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Engineering The Humanities

EXCERPTS FROM PAPER* BY

Eugene E. Wilson, Former President, United Aircraft Corp.

* Paper was presented at SAE Southern New England Section, Hartford, Conn., Feb. 13, 1951.

SOME 36 years ago, while I was a Navy postgraduate engineering student at Columbia University, I read a paper before the ASME called "A Basis for Rational Design of Heat Transfer Apparatus." That word "rational" reflected the character and philosophies of my wise teacher, Dr. Charles Edward Lucke, then Dean of Mechanical Engineering at Columbia. Today, with the heat on us in world affairs, we all seek some apparatus for transferring it elsewhere and for rationalizing that process. I therefore propose to apply Dr. Lucke's scientific method to a demonstration of the vital role the engineer may play in helping to lead the way out of our current confusion.

Our first need is for a clear statement of long-term objectives. It was owing to the lack of such a purpose that the present crisis was precipitated. For lacking one we have not been able to conceive even a military strategy other than that reflected in such slogans as "Unconditional Surrender" or "Victory Through Airpower." These reveal almost complete dependence upon physical force and, latterly, upon a single superexplosive, the A-Bomb.

Now this dependence upon material superiority has begun to take on some of the aspects of a Maginot line, one flanked right and left and breached in the center by sheer manpower. In Korea, power-packed tanks have bogged down before the stampede of twin-humped camels and diminutive Siberian ponies. Mighty jet aircraft, though unopposed in the air are frustrated for lack of "suitable tactical targets" on the ground; such, for example, as modern mechanical transport. Even the atomic stockpile dwindles before an enemy who refuses to offer attractive industrial targets; such, for example, as we afford him. It is all too reminiscent of the beating Hitler took when he employed his superior technology against vast Russian hordes.

An engineer will be struck immediately by a singular coincidence. The collapse of our fortunes and the decline of our influence correspond chronologically with the rise of our overwhelming productive capacity. This suggests that we may do well to inquire into the policies under which we have developed and applied it, with a view to discovering, if possible, the principles—or lack of them—which have directed its use—or misuse.

Fortunately this calls for no intensive research into ancient history. For example, we in the aeronautics branch still retain vivid recollections of the bitter controversy which has raged ever since that December day at Kitty Hawk in 1903 when the Wrights demonstrated mechanical flight. The conflict developed between two schools, the one led by the Wrights, who visualized the airplane primarily as a vehicle, and thus a potential boon to civilization, and the other, led by the military, which saw in it a revolutionary weapon.

To Americans, inexperienced in the ways of the Old World, the airplane held greater appeal as a possible means of reducing excessive expenditures for defense, than as a revolutionary means of commercial transportation. If Europeans pictured airpower as a cheap means to conquest, and we Americans thought of it as a cheap means to security, both seem now to have been deceived. So far it has produced neither victory nor security and there is nothing cheap about it—the way it has been used.

As far back as 1909, Gen. Giulio Douhet had begun to preach his doctrine of conquest-through-airpower or, as it came to be known in this country— "Victory Through Airpower." In 1921, he declared, "There is no comparison between the efficiency of direct and indirect destructive action against the vital resistance of a nation. In the days when a nation could shield itself behind the stout armor of an army or navy, blows from the enemy were barely felt by the nation itself, sometimes not at all." The General had the antidote for this, to him, unhappy situation. "The air arm, on the contrary," he wrote, "will strike against entities less well organized and disciplined. A body of troops will stand fast under intensive bombings . . . but workers in a shop, factory or harbor will melt away after the first losses."

Had we engineers been less preoccupied with the fascinating technology of aeronautics, we might have taken issue with this bold assertion, for history records many instances in which men have willingly

Eugene E. Wilson, former president, United Aircraft Corp., delivering his address, "Engineering the Humanities" at the Silver Anniversary meeting of SAE Southern New England Section. He is a past-chairman of the Section

faced frightful consequences in defense of their homes. Yet, since few questioned the Douhet doctrine, it found ready acceptance among the military minds of that era which was to produce Balbo and Mussolini, Goering and Hitler. And their disciples continued to preach the gospel even after experience had failed to support the theory. When the Germans and Italians first tested out the tactic during the Spanish revolution, the defenseless citizens of Madrid not only failed to fold up but reacted with fanatical resistance. So, too, later did the citizens of London, Berlin, Tokyo, Moscow, and other cities. At Hiroshima, thanks to the A-Bomb, the theory seemed to have been demonstrated, but the issue has since been clouded by discovery that the Japanese government had already decided to surrender to the pressure of the sea blockade.

Sober second thought now suggests that the blockade may have proven the more efficient in the long run. Certainly it has turned out to be the more economical because we are still pouring out treasure to rebuild institutions we ourselves battered down. On the score of frightfulness there may be little to choose between the two methods but one thing is now clear; neither our natural allies nor our late enemies relish the idea of being again "liberated" by us under such tactics as we have demonstrated. Perhaps there is some connection between these things and the fact that the Russians, whom experience has thoroughly grounded in the principles of war and diplomacy, still adhere to their policy of using aircraft primarily in conjunction with ground forces and against legitimate military targets rather than civil populations. Meanwhile their propaganda stresses their preoccupation with atomic energy as a means of speeding vast public works—in the public interest. And so, with Grandmother Russia masquerading as Little Red Riding Hood and Uncle Sam as the Big Bad Wolf, everyone is cast out of character until the play becomes not just a farce but a tragedy.

Meanwhile, the Phophet Douhet, having asserted a theory, promptly accepted his own pronouncement as an axiom and pushed on to state his thesis: "No aerial defense, because it is practically useless. No auxiliary aviation because it is practically useless and superfluous. Instead a single Independent Air Force, to include all aerial resources of a nation, none excepted. That is my thesis." By what logic this thesis was derived from such premises remains obscure but since it suited the purposes of Douhet's followers they shouted it from the house tops.

Now, the peculiar traditional notion which Douhet scorned just happened to be the keystone of the arch upon which our Western Christian Civilization was founded, namely the humanitarian object of ameliorating the destructiveness of war. It was upon this idea that our society rested its claim for recognition as a peak in the evolution of the human spirit. In time it had come to provide the inspiration of that great body of international law under which order, direction and creative impulse had characterized the Christian Era.

Similarly, the application of the code of chivalry to limit the destructiveness of war was based not alone on good morals but also on sound economics and good politics. It offered the practical advantage that a victor might win the peace as well as the war. He could inherit something better than a scorched earth and might even induce the vanquished to help him support the terms of a reconciliation. The code has now been relegated to the Boy Scouts where it continues to inspire good deeds among the youths of all creeds and nationalities. For it, too, combines the inspiration of moral precept with an appeal to enlighten self-interest, which is a prerequisite to sound morals. More important, it gives direction to constructive long-term objectives and thus helps to solve current pressing problems. For example, in warfare it tends to convert the mission of armed force from that of wanton destruction to one of guaranteeing the security of transport and communications, itself the master key to social, economic, and military security.

Our blind following of false prophets has tended to undermine our national character. After we had meekly accepted the decision of our political leaders to dishonor our solemn covenants in support of international law, and to treat them as so many scraps of paper, the way had been paved for further lapses.

Step by step we allowed our consciences to be lulled into accepting as inevitable certain persuasive social and political doctrines wholly at variance with the precepts under which the nation had flourished. Today we are ruled by a multiplicity of self-perpetuating agencies no longer responsible to public opinion. Inaugurated ostensibly to safeguard our interests, they have come to suppress our liberties, usurp our authorities and commit us to policies calculated to increase their power.

It is seldom now that ideas are held up for public appraisal as to their spiritual value. Instead, they are imposed on us through slogans and catch-phrases calculated to discredit the possibility that the individual might resolve current problems through his own clear thinking and to persuade him

to place dependence on the leadership regardless of the blunders it makes. This technique, aided by the mechanics of modern supersalesmanship, strikes at the heart of the American philosophy which recognized that the intuitive reactions of everyday men of sound moral character are more likely to be right than the tortured mental processes of self-styled "intellectuals," devoid of spiritual faith.

For it is such as they who have led us astray from the basic ideal upon which our republic was founded, namely, the Christian concept of liberty of the soul. It is clearly recorded that Christ refused proffers of temporal power and deliberately directed his efforts toward furthering the evolution of the human spirit. He sought not to compel social or other reform by law but rather to reform men's spirits. His ideal of a fair break for the other fellow was both humanitarian and practical and it so proved wherever employed. Among other things of peculiar interest to our country, it inspired the first written document under which men covenanted to abide by just laws of their own making. The Mayflower Compact declared that Plymouth Colony was founded "in the name of God" and "for the glory of God and the advancement of the Christian faith."

This inspiration was later incorporated into the Constitution of the United States. The founders of our nation were no mere revolutionaries, but men of high character who combined a profound knowledge of political philosophy with strong spiritual faith.

But today the sirens scream to warn us that we have gone through a stop-light. Aside from military reverses in Korea, we begin to discover that our economic security is in serious jeopardy.

Our forefathers, with their gift of faith and the logic to support that faith, developed high courage which won for us our precious liberty. We engineers received, among other things, the revelation of the priceless secret of mechanical flight. However, the military mind, influenced by Old World conflicts and prejudices, diverted our technology from its constructive functions into the creation of weapons of conquest.

Having become self-centered through superabundance, we drifted into complacency and finally such apathy that we have all but returned to bondage. For when we willingly abdicated all our authority over the A-Bomb, whose very existence had been concealed from us, into the sole custody of whoever happened to inherit the Presidency, we created a potential world tyranny by consolidating in a single individual such power as ought never to have been delegated to the noblest man in existence.

Well, at least this reveals to us at last our own long-term objective:

"That There Shall Be, Under God,
A Rebirth Of Freedom"

And the way to gain it is clearly set forth in the history book: We must concentrate all our forces, material and spiritual, upon the task of safeguarding to individuals of every creed, color, or previous condition of servitude, their inalienable right to freely exchange their goods, their services and their ideas, one with the other. In practice this means that the airplane, for example, must team up with every other form of transport to break down every barrier, natural or artificial, which now presents a roadblock to human progress. Then, just as the Great Chinese Wall, once deemed impregnable to armed force, crumbled beneath the feet of private traders, so would the Iron Curtain, the Bamboo Curtain, The Rubber Curtain, and every other sort of curtain, lift to welcome individual initiative and enterprise offering common personal advantage.

Public announcement of some such program, supported by a pledge to channel technology into increasing human welfare, would put those now bent on enslaving men's minds strictly on the defensive. It would bring renewed hope to free spirits now entrapped behind physical barriers, and speed germination of the seeds of self-destruction still latent in regimes committed to slavery. It would inspire in us and our natural allies the high morale essential to the solution of current problems. It would speed constructive technology for, as we engineers know full well, we owe a heavy debt to foreign ideas conceived and exported to us when science was free and international.

In closing, I venture to paraphrase the prediction of my distinguished mentor, Dr. Lucke, and to forecast that when the engineer, that synthesis of the practical with the scientific, expands his scope to encompass the spiritual as well, he will become the architect of that new Society by putting uplift into the airlift.

Beginning on Page 54 . . .

. . . complete editorial coverage of the SAE National Passenger Car, Body, and Materials Meeting

To Own or to Lease

An Owner's Answer . . .

BASED ON PAPER* BY

Walter Langseder, Automotive Fleet Supervisor, Thomas J. Lipton, Inc.

* Paper "Why Company Vehicle Ownership Pays Off for Thomas J. Lipton, Inc.," was presented at SAE Metropolitan Section, New York, Oct. 5, 1950.

COMPANY car ownership pays off for Thomas J. Lipton because it costs us about 19% less than leasing.

First let's look at the high-sounding argument about capital investment. Leasing companies must borrow the money to buy the cars they rent us. And they borrow it at a high interest rate. In his book, "Automotive Transportation Industry," here is what Sam Lee says:

"The leasing company must borrow the money at the bank, and in most cases, does not enjoy the low interest rate available to many large corporations. In actual practice, therefore, the leasing company becomes an agent for the corporation in negotiating a finance deal for its automotive equipment."

Lipton management tells me we can borrow money at a minimum interest rate and it's no problem. It's just a question of which has the better Dun & Bradstreet rating—the leasing company or Lipton.

We gain too on operating costs. Table 1 shows how our average operating cost per car in 1949 stacks up against the same cost involved had we leased cars. It shows we save $216 per car per year. Multiply that by our fleet of 400 and it shows a saving of $86,400. And we also have the equity you don't have in a leased fleet.

Let's take the overhead cost angle. Business firms operating through leasing companies would seem to reduce costs by cutting bookkeeping and administration problems. But the opposite is true.

We have a scattered fleet. Salesmen would still have to send us records and reports, just as they do now. But we would have to forward most of this to the leasing company. We would not save time or money.

Our cost of fleet supervision and control was 0.002¢ per mile last year. And our fleet department operating on a company-owned basis, is presently geared to handle twice the number of units we now operate.

Bringing the leasing company into the act is like the eternal triangle. Troubles that begin like a grain of sand can grow into a small mountain overnight.

Company ownership basis at Lipton has been vital in boosting our sales organization's morale and efficiency. We give our salesmen personal use of the car. The cars carry no company emblem nor identifying paint color. We do not limit personal use of the car and charge the salesmen a minimum rate for personal mileage.

Lipton provides each salesman with a new car every two years. Equipment failure causes a minimum of lost time. In the last year, we lost one week's time for our entire fleet because of mechanical failure.

Gripes about mileage inequities, plentiful when salesmen owned their cars, have completely disappeared. We pay all expenses and now operate our fleet at less money than before.

We feel that a company-owned passenger car fleet is the only thing for us. Others who investigate it will probably find the same is true for them.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Table 1—Cost of Company-Owned Versus Leased Passenger Cars

	Company	Leased
Depreciation	$323	$720 (rent at $60 per month)
Interest	21	-
Insurance (Average)	75	75
Gasoline	279	279
Oil	25	-
Repairs	58	-
Tires	20	-
Washing	13	13
Greasing	14	-
Storage	24	24
Tolls and Meters	38	38
License Taxes & Miscellaneous	43	-
Total	$933	$1149

Motor Vehicle Fleets?

. . . A Leasor's Answer

BASED ON PAPER* BY

Howard J. Willett, Executive Vice-President, The Willett Co.

* Paper "A Leasor Looks at Leasing," was presented at SAE Metropolitan Section, New York, Oct. 5, 1950.

WHETHER it's cheaper to own than to lease a fleet depends on the type of operation and annual mileage.

Comparison on the operating end can be looked at in two ways—the overall and the item-by-item approaches.

Take the overall approach first. Both leasing company and company fleet should operate about the same, given the same facilities. Only difference is the leasing company's profit.

Suppose a company sets up a motor vehicle department, hires a competent automotive engineer, invests in personnel and necessary equipment to do a top job of purchasing, accounting, and servicing, plus an A-1 job of using the equipment. If that's the case, there should not be much difference between lease rates and fleet costs.

There no longer are any secrets to motor vehicle engineering, purchasing, depreciation, servicing, and preventive maintenance. What's available to the leasing company is available to the company fleet man, thanks to sources such as SAE transportation and maintenance papers.

The company that doesn't install a complete automotive department is headed for trouble. As has often been said, "If you don't run the trucks, the trucks will run you—and probably ruin you."

On an item-by-item basis, both leasors and fleet operators have claimed each can buy things cheaper. But as a truck leasor, I was faced with a showdown.

Recently the National Truck Leasing System bid on a job involving vehicle operating for a large company. The company manufactures several automotive products. It wanted us to bid on a cost-plus contract, to which we were agreeable.

We offered a guarantee that our cost plus overhead and profit would never exceed the cost now being paid by the company for any single item consumed by the trucks. We made a few exceptions, such as licenses, but were willing to bid on everything else down the line, including maintenance labor and parts, gas, oil, alcohol, chains, and tires.

We could do this for one reason. This company operated hundreds of vehicles all over the country. But in each city these fleets represented only small additions to our present operations. On an item-by-item basis, the leasing company was cheaper than the fleet operator.

Often fleet operators get bids from leasing companies which differ a lot from their own costs. Only way for this to happen is either the leasing bids or company costs to be wrong. Often the comparison is confused. The leasing company quotes on "apples" and "peaches" are used against it.

Our company profit is no more than 10%. That's a matter of public record, since we come under the Interstate Commerce Commission rules for accounting. In fact, over the past 10 years our profit was exactly 6.16%.

Assuming that a company fleet man and I were both going to do exactly the same job and pay exactly the same price for every component, then our charges to him would be about 10% higher than his cost. This 10% represents our profit. It would be the worst figure; chances are we would find some savings along the line.

"But is leasing cheaper?" you ask. We can say daily rental of cars and trucks is definitely cheaper than some alternatives, depending on the alternatives. We also feel annual car leasing is cheaper for the company if operating over 40,000 miles per year. It's cheaper for the company to do it under 12,000 miles annually. Just where the break-even point comes between 12,000 and 40,000 miles depends on the individual situation.

Long term truck leasing is cheaper with a small or scattered operation. There is not too much difference in price with large, well-operated fleets.

There are lots of reasons why companies lease, even though it may be more expensive. Some companies want the additional capital from sale of their trucks for profit-making investments. Others don't want the responsibility of fleet operation and the headaches it entails.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Removing and Moving

GREATER productivity aimed for in mining iron ore in Minnesota is bringing increased capacity in all equipment, especially for loading and hauling.

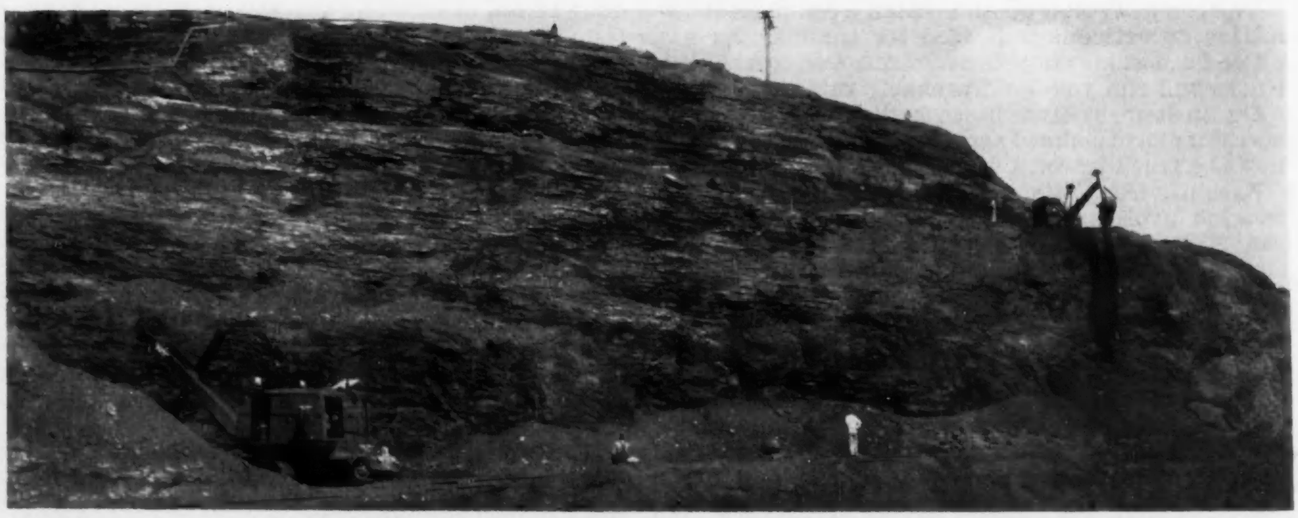
Shovels and draglines powered by gas, diesel, or electricity load nearly all the ore or waste material handled on the Minnesota iron ranges. The remainder—surface material—is handled by self-loading scrapers using their own power, or those drawn by tractors. Scraper use is limited. It can't load in ground that contains many boulders, as does the glacial till on the iron ranges.

The greatest part of the material is loaded with close-coupled quarry-type shovels driven by electric power. These shovels have dipper capacities from 4 to 6½ or 7 cu yd. During the last two or three years large electric draglines have loaded a steadily increasing amount of the surface stripping. These machines are equipped with buckets ranging in capacity from 7 to 30 cu yd. Gas and diesel-powered shovels and draglines account for the remaining material loaded by this type of equipment.

Most excavating machines powered by internal combustion engines use diesel power. They range in size from ⅜ to 3½ cu yd. The greatest number are 1 to 2½ cu yd in size. The smaller sizes are used for digging foundations, ditches, handling timber, in loading operations in small mines, and on clean-up or "scram" operations. The larger sizes are used extensively for loading iron ore and also in many surface stripping operations.

One special use for the smaller diesel machines equipped as drag shovels or trench hoes is digging ore out of the deep narrow channels found in the bottom of many pits. Their ability to dig hard material and reach down below the level of the ground on which they stand has made them an excellent tool for this "scram" operation.

The operating controls have been greatly improved during recent years. This has been accomplished in different ways, such as improved booster shoes and the use of hydraulic, compressed air or vacuum operated controls. One of the more recent innovations is the use of magnetic clutches. Efforts to improve the operating controls should not



Scramming operations at Hull-Rust Mine, Hibbing, Minn. This shows the kind of terrain on which some of the machines described in this paper operate

Minnesota's Iron Ore

EXCERPTS FROM PAPER* BY

John H. Hearding, Jr., General Superintendent, Oliver Iron Mining Co.

* Paper "Earthmoving Equipment on the Minnesota Iron Ranges," was presented at SAE National Tractor Meeting, Milwaukee, Sept 12, 1950.

be relaxed. Any improvement which will lessen the physical effort required by the operator will result in more output by the machine.

Machine components should be more accessible to permit better inspection and more rapid replacement of worn or broken parts. The machines should be made easier to lubricate. Centralized lubricating systems should be used wherever possible.

Here is what one mining company did to improve operating characteristics of a 2½-cu-yd shovel. It replaced the 6-cyl diesel engine (rated at 170 hp at 900 rpm) with an automotive type diesel engine rated at 243 hp at 1600 rpm, driving through a 17-in. torque converter. Cost of the automotive type engine and the torque converter, plus the installation charges, was slightly greater than the original cost of the heavier, slower-speed diesel engine.

But here is the payoff: The shovel operating speed increased materially and the output rose about 10%. This machine needs much less maintenance and cable life has improved.

Hauling Methods

Rail haulage has been used in the Minnesota mines since the very beginning. It continued to be the only haulage method until about 1935. The first trucks were introduced at that time. Belt conveyors also are beginning to play a big role in transporting ore.

Prewar hauling trucks had a 20,000 to 30,000-lb capacity. Today end dump trucks with capacities from 44,000 to 68,000 lb are in general use on the Minnesota ranges. The 44,000 and 60,000-lb capacity trucks use engines of 275 or 300 hp. Tire sizes on these trucks range from 18.00×24 to 18.00×32.

Single-drive axles are used on the 44,000-lb trucks, but the 60,000-lb trucks may be had in either the single-drive axle or the tandem. Experience indicates that the single-drive axle for the 60,000-lb truck is not as good as the tandem. Struck measure capacity of the boxes for the 44,000-lb trucks is 14.8 cu yd; for the 60,000-lb trucks, 20 cu yd. Tare weight of recent 60,000-lb trucks is 53,000 lb.

The 68,000-lb capacity trucks now in use are equipped with two 190-hp engines, each driving through a torque converter and separate drive shaft to one of the axles in the tandem unit. It is also possible to get this truck with a single 400-hp engine driving through a torque converter and a power divider then through the two drive shafts to the two axles of the tandem unit.

Early rubber-tired haulage vehicles on the iron ranges were largely the rear dump trucks. There followed some installations of side-dump semitrailer units, having a struck measure capacity of 16 cu yd. More recently, bottom-dump, semitrailers have been put into service. These are of several sizes; the largest has a capacity of 25 cu yd and a payload rating of 80,000 lb. Other rubber-tired haulage vehicles with capacities of 80,000 lb or more have been tried experimentally. Up to now they have been limited to a very small number of units.

Supplementing the larger haulage units are small end-dump trucks, varying in size from 4000 to 20,000 lb, powered chiefly with gas engines. These units are used in the very smallest pits and for clean-up or "scramming" operations in the larger pits. They move a very considerable tonnage each ore season.

Rear-dump trucks will remain the most popular type; but tractors with bottom-dump semitrailers will be more generally used for both overburden removal and ore hauling work. Cost per yard of material handled will govern the popularity of these two vehicle types.

One outstanding improvement has been the use of torque converters. During the past two years much experimenting with torque converters has been undertaken by the different companies. Torque converters are being specified on many new trucks purchased. In a short time few, if any, trucks will be purchased without them.

Another improvement, the exhaust-heated truck box, makes it unnecessary to use salt, calcium chloride, or other means to prevent freezing of the material to the boxes. It improves the handling of sticky material by drying a thin layer next to the

Machines that Ply

The low grade material being loaded into 30-cu yd stripping cars by the 5-yd shovel will be taken to a stock pile. The 1000-hp diesel-electric locomotive weighs 122 tons.

This 3/4-cu yd drag shovel is scramming iron ore off rock at the Hull-Rust mine at Hibbing, Minn.

Oliver Iron Mining Co. uses 30-ton trucks to haul ore at its Monroe mine. A 5-cu yd electric shovel in the foreground is loading these trucks.

box which prevents the load from sticking.

Truck haulage generally has been confined to properties where the one-way haul was not over a mile. It is doubtful that this will increase. The trend is to decrease the length of haul and substitute inclined conveyor belts to lift the material. Seven percent grades are generally the steepest economical for truck haulage.

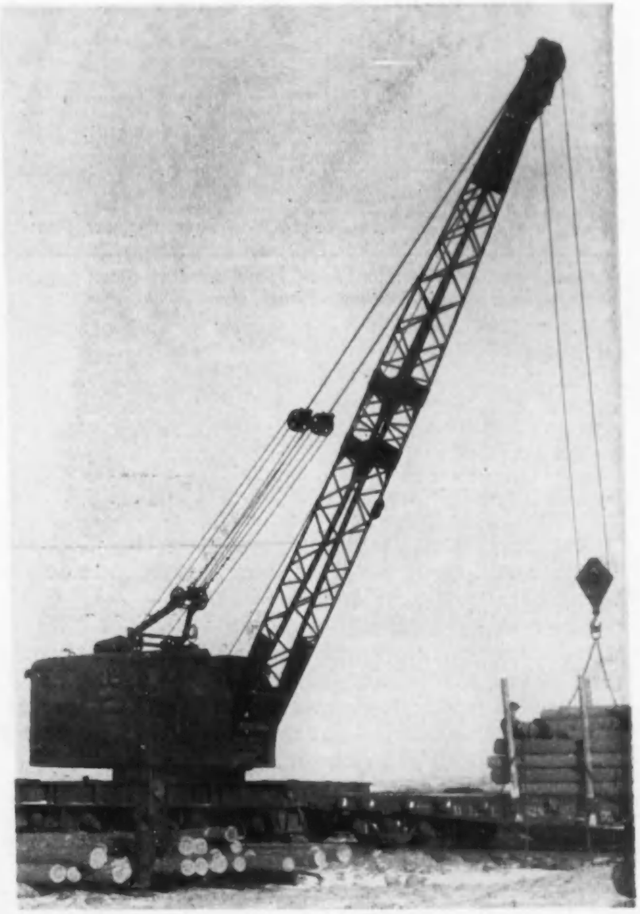
Use of belt conveyors for transporting ore in the mines began about 1937 and has grown steadily since. Trucks gather the ore and transport it to the receiving end of the belt; from here it is moved to the processing plant or shipping pocket. In this type service the belts are generally 30 in. wide in lengths up to 1800 ft centers, and travel at speeds up to 600 fpm.

During 1948 the first belt conveyor installation to handle surface stripping was put into operation. This conveyor system consists of several flights of 48-in. belt. It transports the stripping about 7000

the Iron Ore Mines

Among the machines used in scramming operations at the Hull-Rust mine is this 1 1/2-cu yd shovel. It is loading 16-cu yd crawler-mounted wagons hauled by 20-ton tractors.

Smaller equipment also plays a part in scramming or cleaning. Typical of such machines is the 3/4-cu yd diesel drag shovel loading ore into a 6 cu-yd Dumptor.



The timber being unloaded by the 50-ton diesel locomotive crane is for mine trestles. Since 1940, diesel locomotive cranes have been replacing steam machines. Early diesel cranes propelled themselves through a long train of gears. This limited their ability to propel long distances. Electric propulsion was introduced in 1948, giving much more mobility.

ft and deposits it by means of a stacker conveyor in a semicircular dump 150 ft high. A traveling hopper loads this conveyor system. It feeds the main belt by means of a short 60-in. conveyor. The traveling hopper receives the output of a 30-cu yd dragline.

The ordinary conveyor belt with duck carcass is satisfactory for short flights and low lifts. Cotton or rayon cord gives strength for long flights and high lifts. For extreme lengths and lifts, steel cord conveyor belts are required. One such installation is 1622 ft long with a vertical lift of 352 ft.

Conveyor belt use has steadily grown on the Minnesota iron ranges. In 1941 there were six installations with a total length of 9110 ft; this has grown to 28 installations totalling 46,816 ft in 1949.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Two-Cycle Diesel Altitude

BASED ON PAPER* BY

R. W. Guernsey, Senior Engineer, Detroit Diesel Engine Division, GMC

* Paper, "Altitude Effects on Two-Cycle Automotive Diesel Engines," was presented at the SAE National Diesel-Engine Meeting, Chicago, Nov. 3, 1950.

A RELATIVELY easy way to correct the performance of 2-cycle diesel engines for altitude conditions has been developed.

The method consists, briefly, in:

1. Obtaining the complete performance of the engine at one air density, say, sea-level conditions.

2. Plotting constant-speed fuel fishhook curves, which must be carried out to the point where power begins to fall off at overrich air/fuel ratios.

3. Developing charts similar to that shown as Fig. 1, which contains a complete portrayal of performance for the GM 6-71 engine at 2000 rpm, both at sea level and at altitude.

The altitude scale corresponds to the NACA standard barometric values and an air temperature of 60 F. The maximum power and the smoke limit occur along lines of constant air/fuel ratio.

As an example of the use of the chart, let us take the 70 cu mm line, which represents the engine rating for highway truck service. Starting at an air density of 0.0765 lb per cu ft, or sea level, we find that the bmep decreases at the low rate of approximately 1 psi per 1000 ft up to 6000 ft above sea level. The engine is then at the smoke limit. In the zone from sea level to 6000-ft altitude, the air/fuel ratio is changing as the altitude changes.

To avoid smoke at higher altitudes, the injector input must then be reduced progressively, so that the air/fuel ratio will remain at 27. Along this line of operation the bmep decreases at an average rate of 3.3 psi per 1000 ft up to 16,000 ft above sea level, a rate that is 3 1/3 times as great as the initial rate of decrease.

The climb from 6000 to 16,000 ft could have been made at greater power output if smoke had been disregarded. In such a case, the injector input would not have been changed up to 11,000 ft. The rate of decrease of bmep would have been only 2 psi per 1000 ft between 6000 and 11,000 ft. Above this altitude, the engine would be operated along the maximum-power air/fuel ratio of 20, with an average decrease of 3.4 psi per 1000 ft up to 16,000 ft.

A study of the chart shows why it has been difficult to derive as simple a correction factor for the performance of diesel engines as has been successfully done for carbureted-mixture engines. The performance of a mixture engine, operating at a substantially constant air/fuel ratio, will vary directly with air density along one of the straight lines, for example, the maximum-power line.

In the case of the 2-cycle diesel, operating with a wide variation in air/fuel ratio, there is a considerable range of altitude where the power changes but slightly as the air density decreases. Engines of lower rating are least affected by a change of altitude. In the case of the ratings below 50 cu mm per stroke, the power output actually increases somewhat up to rather high altitudes. A diesel engine that is rated close to its maximum will, however, be far more sensitive to atmospheric conditions, possessing a sensitivity of the same degree as that of a carbureted-mixture engine.

Since the 2-cycle engine has an inherently high power output from a given displacement, it need not be designed at its maximum possible output to be successful in a competitive market. Thus, it enjoys a favorable position with regard to altitude performance.

Development of Method

Tests were made with a dynamometer laboratory mounted on a heavy-duty truck chassis.

The mobile laboratory was driven to a suitable location at each of three altitudes: 500, 5000, and 10,000 ft, where complete performance tests were run. Fig. 2 shows the mobile test laboratory on location at 5000 ft above sea level.

A GM 6-71 2-cycle diesel engine of the uniflow

Corrections

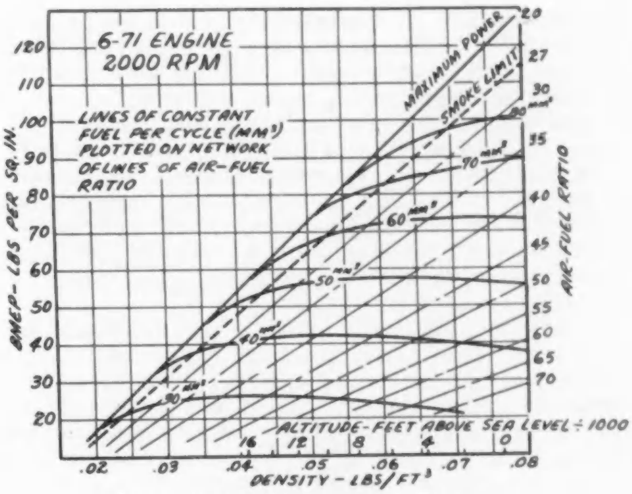


Fig. 1—Altitude characteristics at 2000 rpm

Fig. 2—Mobile test laboratory at 5000-ft elevation

type was used to make the tests. This engine has a bore of 4¼ in., a stroke of 5 in., six cylinders, and a total displacement of 425 cu in. Scavenging is by a Roots-type blower supplying 35% excess scavenging air on the basis of engine displacement.

The air delivery pressure on this test was 17 in. of Hg at 2000 rpm and 500-ft altitude. This pressure varied with the inlet air density, dropping to 11 in. of Hg at 10,000 ft.

The engine has unit injectors, which may be installed in various capacities to obtain ratings from the more conservative values suitable for industrial service to the high-output ratings used for high-speed automotive service. On this test, injectors of four ratings were used: 60, 70, 80, and a special 100 cu mm size. The latter was used only at 500 ft, so as to obtain data on operation at low air/fuel ratios.

The behavior of the engine at 500, 5000, and 10,000

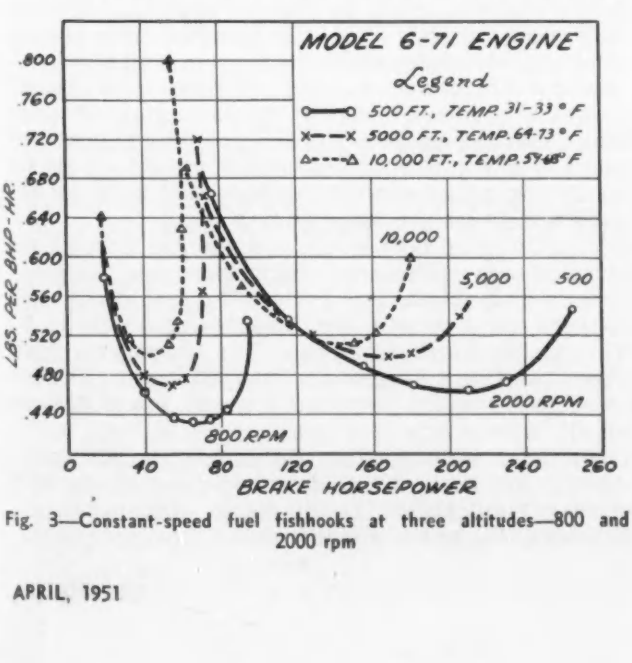


Fig. 3—Constant-speed fuel fishhooks at three altitudes—800 and 2000 rpm

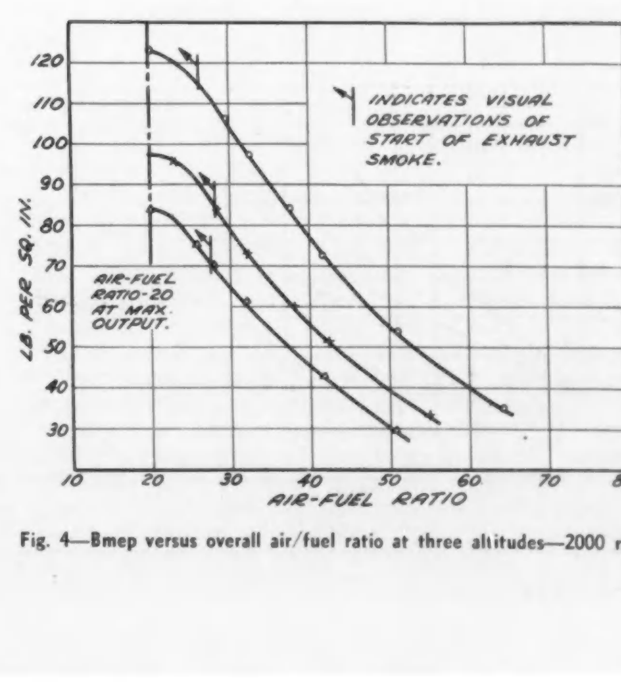


Fig. 4—Bmep versus overall air/fuel ratio at three altitudes—2000 rpm

ft is shown in Fig. 3 as a conventional set of constant-speed fuel fishhooks. It is apparent that there is a variation in performance with altitude, but the fundamental relationship is not evident.

Next, a review of some of the existing literature on the effect of atmospheric conditions on engine performance was made. This work showed that the air to fuel ratio was the common denominator upon which an analysis might be based. This research work had been performed on 4-cycle engines, and the analytical operations had been done largely on the indicated performance.

It was thought, though, that the fundamental laws must also apply to 2-cycle engines. Preliminary calculations on the basis of indicated performance showed agreement. It was desired, however, to find a simple and direct way to analyze the results, which would not require going back to the indicated performance and the combustion air/fuel ratio existing in the cylinder charge. The results were studied, therefore, from the standpoint of

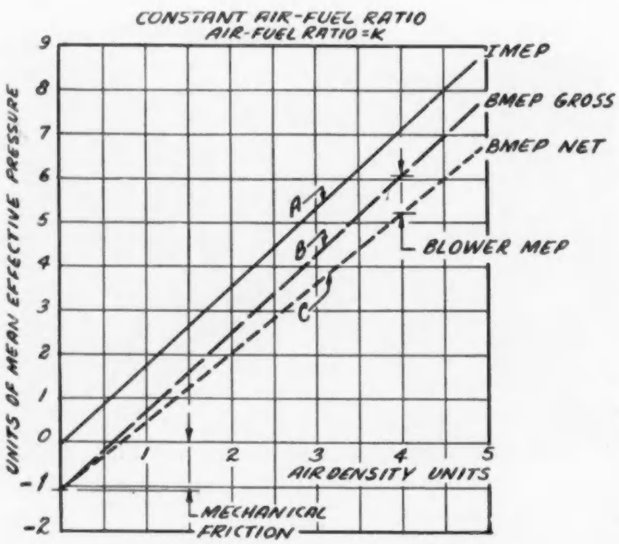


Fig. 5—Chart illustrating elementary theory

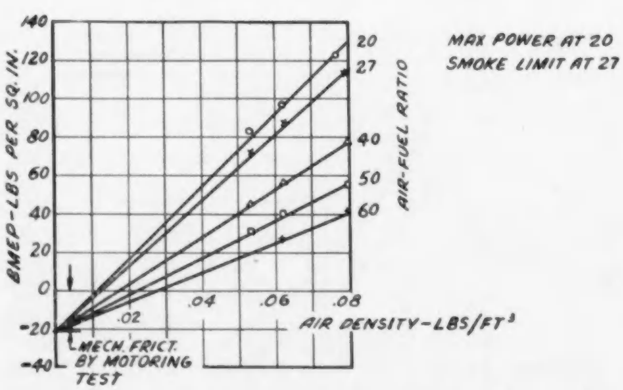


Fig. 6—Bmep versus inlet air density at constant air/fuel ratios—2000 rpm

brake performance and the overall air/fuel ratio including the excess scavenging air.

The overall air/fuel ratio was calculated for each test point from the measured airflow into the blower inlet and the rate of fuel input. An example of the results is shown in Fig. 4, which gives bmep plotted against air/fuel ratio when the engine was running at 2000 rpm.

When these curves are plotted for various speeds, it is seen that the maximum bmep is obtained at nearly the same air/fuel ratio, regardless of air density or engine speed. This is a fact of fundamental importance. Points of observed smoke limit or start of visible smoke are also indicated. The air/fuel ratio at this point is approximately a constant value, although there is a slight variation with speed.

It appears reasonable to assume for a given air/fuel ratio the indicated mep will vary with inlet air density. Ignoring small changes in combustion efficiency and scavenging, we find that this variation will be direct and linear. Line A of Fig. 5 shows such a relation.

Next, if the mechanical friction is independent of density, a line of bmep for an engine with an independent source of scavenging air will be straight and parallel to A. Line B represents such a relation. It lies below line A and intersects the ordinate axis at a negative value that is equal to the mechanical friction. Actually, the scavenging blower is driven by the engine, hence its power requirements must also be subtracted.

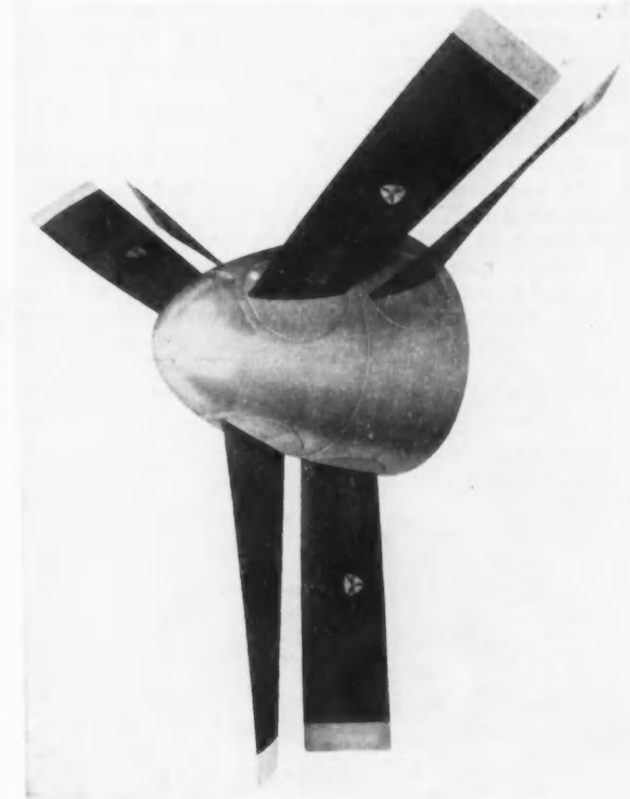
On the engine under consideration the blower is a positive displacement machine of the Roots type. It is reasonable to assume that blower mep will vary directly and in a linear manner with density and will have a zero value at zero density. Subtraction of blower mep gives straight line C, or bmep passing through the aforementioned negative intersection on the ordinate axis. This intersection is of primary importance and will be called the effective origin.

To check this elementary theory, the test data were replotted along lines of constant air/fuel ratio, an example of which is shown in Fig. 6. The agreement with theory is very good. The test points fall along straight lines, which converge on an effective origin corresponding to the mechanical friction. This mechanical friction was obtained by motoring the engine to measure overall friction, and then subtracting the power required to drive a calibrated blower of the same design at the test values of speed and delivery pressure. In all cases the theory appears to be verified within limits of error that are no greater than is commonly experienced between repeated tests on the same engine.

The data are now in a fundamental and useful form. To complete the information, the performance is cross-plotted at various fixed injector rack settings corresponding to the injector inputs of 30 through 80 cu mm per stroke. Fig. 1 shows the final chart for the 6–71 engine for 2000 rpm. Similar charts are readily prepared for any other desired speed.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Fig. 1—The dual rotation propeller at right is designed for the turbine-powered Douglas XA2D airplane above. This carrier-based attack airplane is shown during vibration testing



A Prop For Turboprop Engines

BASED ON PAPER* BY

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Assistant Chief Engineer — Chief, Aerodynamics and Application Department

* Paper "Design and Operation of Gas Turbine Propellers," was presented at SAE National Aeronautic Meeting, Los Angeles, Sept. 29, 1950.

THE Aeroproducts six-bladed dual-rotation propeller for turboprop turbines is built to take the rigors of high-speed flight. It can absorb about 5500 shaft hp. One version of the propeller, shown in Fig. 1, is used on the Douglas XA2D airplane.

This design is basically two independent hydraulic propellers, each with its own oil source, pumps, valves, and accessories. No hydraulic fluid is transferred between the two hydraulic propellers, nor is any hydraulic fluid transferred from the stationary assembly mounted on the turbine gear box.

A mechanical coupling connects the two propellers. It adjusts the blade angle of the outboard propeller according to dictates of the inboard one. A varying blade angle differential is maintained between outboard and inboard components for minimum torque in the engine gear box and on its mounts.

An unusual type seal maintains a continuous fairing for the blade shank spinner juncture. See Fig. 1. Blade seals are attached to the blade shank and rotate with it. This makes a smoother spinner-blade juncture throughout the flight operating range.

Such ideal fairing is not achieved at blade angles for ground handling, reverse pitch and feather. But under these conditions the increased drag and turbine ram recovery are not so critical.

Each component of the dual rotation assembly consists of two major subassemblies: (1) a one-piece hub in which are mounted the blades and their pitch-changing mechanisms, and (2) the regulator,

which contains the hydraulic operating medium and the pumps, valves, and governing mechanisms. These components are essentially the ones used in previous Aeroproduct propellers.

Fig. 2 shows a schematic cross-section of the inboard hub and regulator assembly.

A torque unit changes pitch. This unit is mounted on the hub barrel and extends into the blade shank. The mechanism consists of the piston with internal and external helical splines, mounted between an externally splined hub-mounted member and an internally splined member connected directly to the blade. Applying hydraulic pressure on either side of the piston gives it axial motion, which changes the pitch.

A ring gear coordinates movement of all blades.

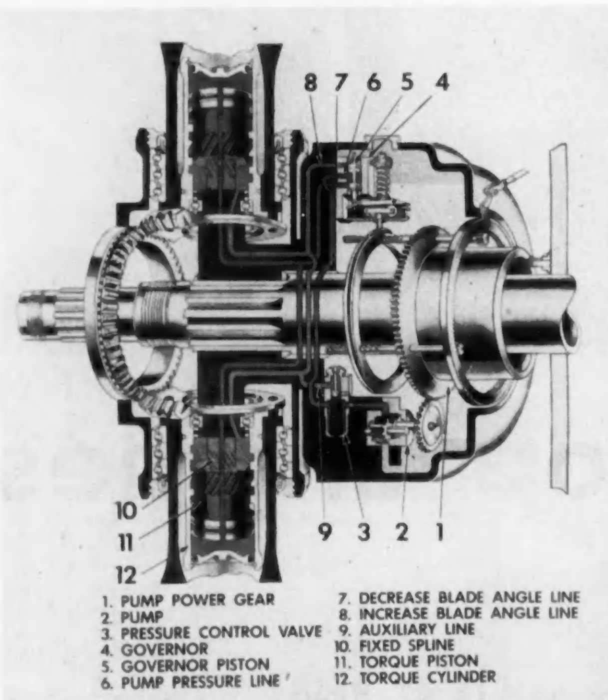


Fig. 2—Schematic cutaway of inboard components of dual rotation propeller

The ring gear meshes with a segment gear attached to each blade root. This ring gear also transmits blade angle intelligence to the regulator mechanism of the outboard propeller.

Fig. 2 also shows the conventional angular contact ball bearing stack used in the hub socket. An external ring nut retains the bearing stack on the blade.

The regulator has an aluminum housing containing an oil reservoir, pumps, control valves, and so forth. This unit is mounted directly behind the hub. Gear-type pumps, driven by a stationary ring shown in Fig. 2, provide hydraulic pressure. Centrifugal force makes the oil within the regulator assume an annular shape. Under operating conditions, the air space within the regulator is maintained at atmospheric pressure.

Fig. 3 shows the interior of the inboard regulator with the cover removed. In this assembly are three pressure-loaded gear pumps. They are arranged so that two pumps operate continuously. In case either of the two pumps fails, the third one cuts in to prevent oil flow loss.

A small electrically-driven pump shown provides oil flow when the propeller is stationary. This small auxiliary pump permits unfeathering in flight. It also allows blade angle adjustment to minimum torque position before starting the turbine. The outboard regulator has a similar pump arrangement.

The inboard regulator also has an electrically operated hydraulic valve. Controlling the valve is the electronic turboprop governor mounted in the engine nacelle. An integral hydraulic governor is mounted in the regulator for standby speed control.

Should the electrical system fail, the hydraulic governor takes control. This centrifugal governor does not give as close control as the electronic unit, and doesn't furnish synchronization between engines; but it is satisfactory for emergency use.

The standby governor consists of a piston valve attached to one end of a lever. It operates against a compression spring. As the governor rotates within the regulator, centrifugal force moves the piston outwardly against spring force. At control rpm, centrifugal force on the piston is balanced against the spring load; the piston remains in a neutral position.

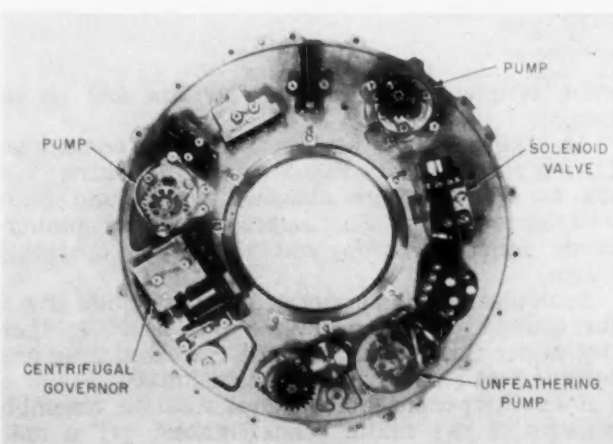


Fig. 3—Inboard regulator without cover

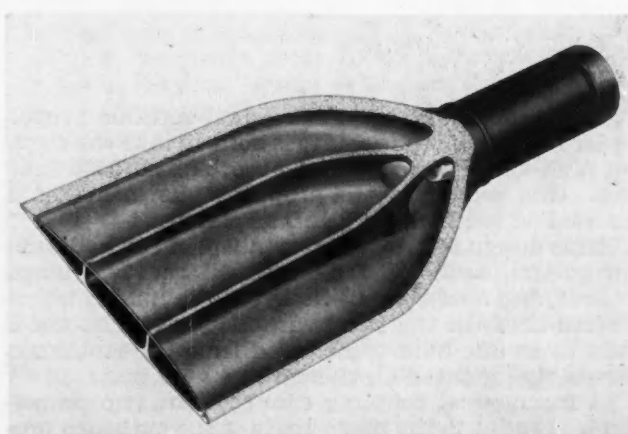


Fig. 4—Cutaway of propeller blade. This is the thrust member of the two-part blade. The other component, of alloy steel sheet, is brazed to this forged part

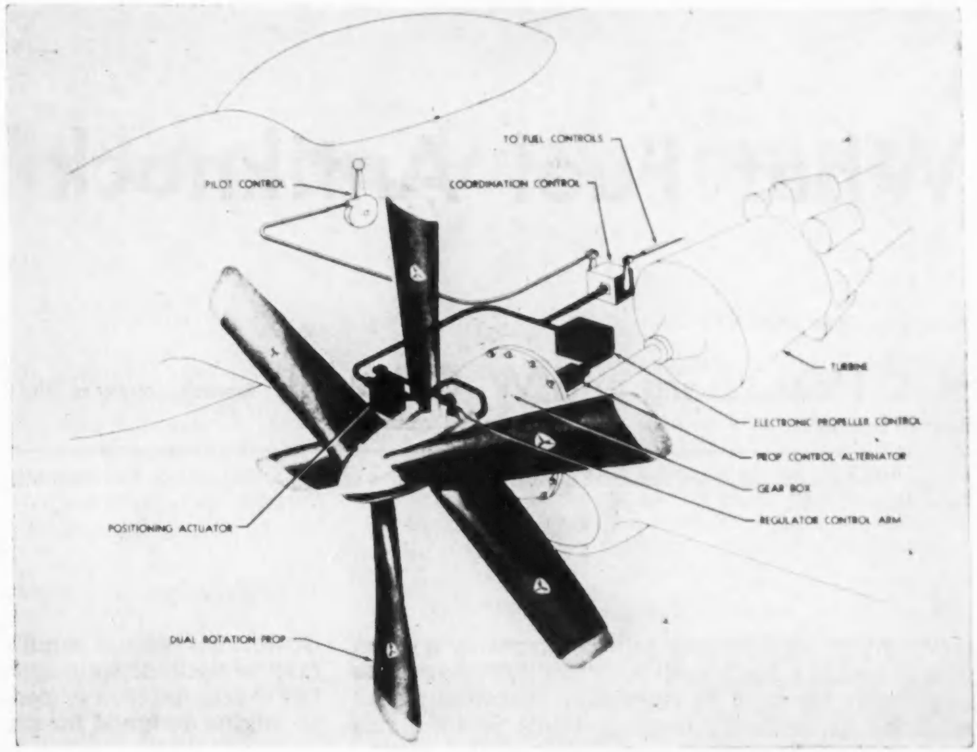


Fig. 5—Basic propeller control configuration for a turbine engine

Fig. 4 shows the hollow steel blade used in later model turboprops. The blade consists of two members brazed together. The thrust member is a machined steel forging that forms the thrust face, blade shank, longitudinal ribs, and leading and trailing edges. A camber sheet of alloy steel is copper brazed to the thrust member to complete the blade structure.

The blade is rust-proofed internally, filled with inert gas, and then hermetically sealed by a balance cup inside the shank. A blade fairing or cuff is attached to the cuff ring on the blade shank. It provides aerodynamic fairing for the elliptical and round sections of the blade.

Fig. 5 diagrams a propeller and control installation for a typical turbine. Indications from the pilot's control lever are transmitted to the propeller control system through a coordinating control. This is part of the engine manufacturer's equipment. It schedules and transmits desired fuel flow, propeller speed, operating blade angle, and other functions.

Signals from the coordinating control can be transmitted either mechanically to the propeller, or electrically to a positioning actuator. In the first case, the coordinating control positions the input of the electronic control. In the second case, a motor in the actuator positions both the propeller regulator arm and the input to the electronic control.

When the blade called for is outside normal governing range, the electronic control is automatically disconnected. The propeller then operates as a blade angle selection unit, according to dictates of the regulator control arm position. With this feature, the propeller can be feathered without external electrical energy.

A shortcoming of electronic equipment in the past has been servicing and maintenance troubles with unskilled people. An effort has been made to simplify this maintenance and also make units resist vibration better. Each subassembly is potted in a plug-in unit. Fig. 6 shows several of these units.

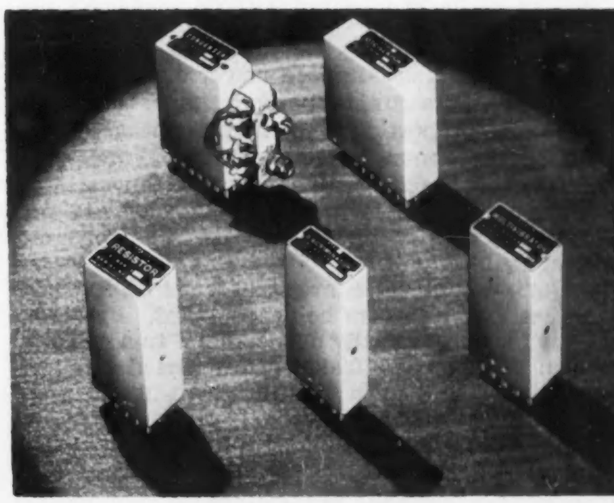


Fig. 6—Electronic units ahe potted in units such as these. They make maintenance easier and show good vibration resistance

They are adjusted before potting and may be installed in the electronic control without any circuit adjustments. The assemblies contain tubes, resistors, connectors, and so forth. Tubes in these units are like the ones for the proximity fuze. They are remarkably resistant to shock and vibration.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

What Fuel Antiknock Quality

EXCERPTS FROM PAPER* BY

H. E. Hesselberg and **W. G. Lovell**, Research Laboratories, Ethyl Corp.
Research Supervisor — Associate Director

* Paper "The Potentialities of Fuel Antiknock Quality," was presented at SAE National Fuels & Lubricants Meeting, Tulsa, Nov. 10, 1950.

HOW much performance gain is offered by a given increase in a fuel's antiknock quality? Answer to this tough question is emerging. Semi-empirical relationships make it possible to relate performance number index of primary reference fuel and knock-limited power output.

This approach to evaluating fuel antiknock quality yields six conclusions:

1. Gains in knock-limited power output at variable manifold pressure (supercharging or throttling) are directly proportional to the percentage change in performance number requirement.
2. Gains in knock-limited compression ratio accompanying increases in antiknock level are proportional to the percentage increase in performance number requirement.
3. Compression ratio largely determines fuel consumption, other factors being constant. Fuel consumption is substantially proportional to a constant fraction of air-cycle efficiency, for varied compression ratios with a fixed engine design at given operating conditions.
4. Absolute power output with a given fuel varies with engine design. It represents a compromise between desired economy and power.
5. For paraffins and naphthenes, effectiveness of tetraethyl lead in increasing antiknock quality in general is a constant percent of the base fuel's performance number.
6. Engine design factors and changes in engine operating conditions greatly influence relative ratings of "sensitive" fuels. Tetraethyl lead is generally much more effective in these fuels under mild engine conditions.

Fuel antiknock quality may be used in at least one of two ways: (1) to increase the knock-limited power to be obtained from an engine by burning more fuel and air in the engine (the supercharge route), or (2) to increase the amount of useful work from an engine with a fixed amount of fuel and air by increasing the knock-limited thermodynamic efficiency of the cycle (the compression-ratio route). Obviously, various combinations of these methods may be used, depending upon the results desired in the overall picture of performance and economy of an engine designed for a specific use.

Antiknock Quality and Permissible Charge

Incidence of knock limits the amount of air and fuel that may be burned in an engine. It may be easier to try to evaluate this more simple case first in terms of fuel antiknock quality as currently measured.

To do this, it is possible to consider the knock-limited output of an engine operating with variable manifold pressure, other factors such as compression ratio, speed, air and jacket temperatures, and mixture ratio remaining constant. The output may conveniently be measured in terms of indicated mean effective pressure. It is advantageous to consider indicated rather than brake output; the fuel is really used to produce indicated power, even though such measured indicated outputs are the sum of the brake and the friction outputs, and even though all currently used methods of measuring engine friction are subject to some unknown errors.

To evaluate the knock-limited fuel requirement for such conditions, it is also convenient to use for the present purpose blends of the primary reference fuels, n-heptane and iso-octane, and of tetraethyl-lead in iso-octane.

Experimental data on a variety of engines, run at variable inlet-manifold pressure, indicate that the knock-limited output is directly proportional to the performance number of the reference fuels. These data relating knock-limited imep to fuel requirement are shown in Fig. 1. These experimental results were obtained on four different engines—two single-cylinder engines of different compression ratios and displacements at manifold pressures ranging from 15.9 to 55.5 in. of hg abs and two multi-cylinder engines of different types and compression ratios from 12 in. of hg abs to substantially atmospheric pressure.

The knock-limited imep varied from 55 to 210 psi,

Means in Engine Performance

and the fuel requirement from about 20% iso-octane in n-heptane to iso-octane plus 2.0 ml TEL per gal. This knock-limited fuel requirement has been represented in Fig. 1 by the performance numbers of the primary reference fuel blend used.

Use of this arbitrarily expressed performance number scale for expressing antiknock quality offers these five advantages:

1. It is derived from conventional measurements of octane number.
2. It expresses antiknock quality level in terms of power that can be obtained from the fuel. It's convenient because it relates fuel performance more directly than octane number.
3. Fuels below 100 octane number (ordinarily expressed as octane number) and those above 100 (usually expressed as amount of TEL in iso-octane) can be considered in the same scale without changing units.
4. It eliminates possible confusion stemming from the fact that octane number change in the low range represents much less change in the fuel's economic usefulness than a comparable octane number change in the high range. Performance numbers represent the same value throughout the scale.
5. It offers many conveniences and simplifications in evaluating fuels and effectiveness of tetraethyl lead, as will be shown later.

This use of performance number of fuels for evaluating their potentialities in engines is not perfect. If we were redefining fuel antiknock quality at this time, a somewhat different definition might be used. But in the light of current thinking, performance numbers seem to represent the best presently available measure.

The data on a variety of engines indicate that the output is proportional to the performance number of the primary reference fuel, even though the actual

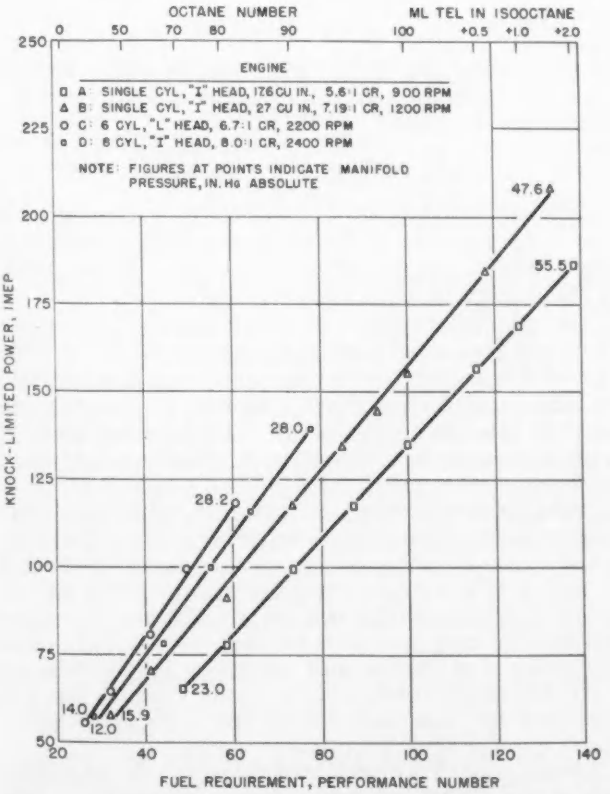


Fig. 1—Relationship of power and fuel requirement at variable manifold pressure

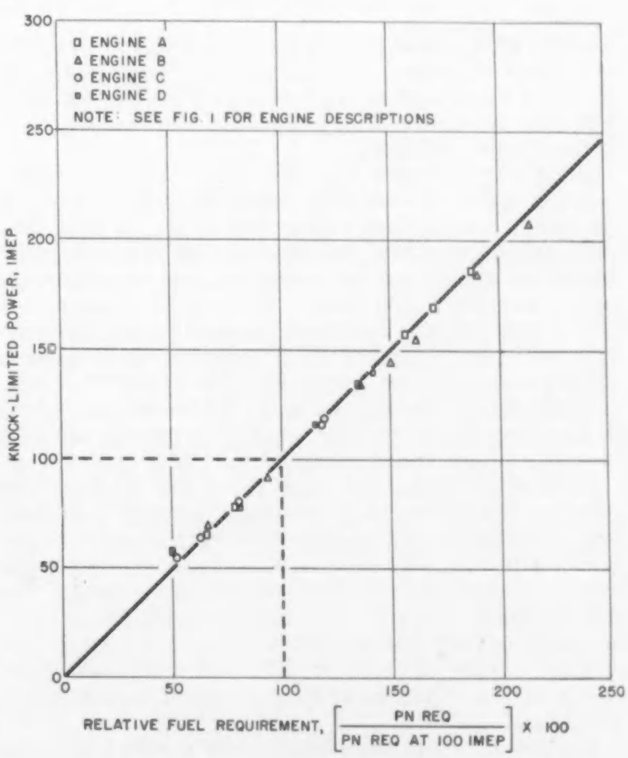


Fig. 2—Relationship of power and relative fuel requirement at variable manifold pressure

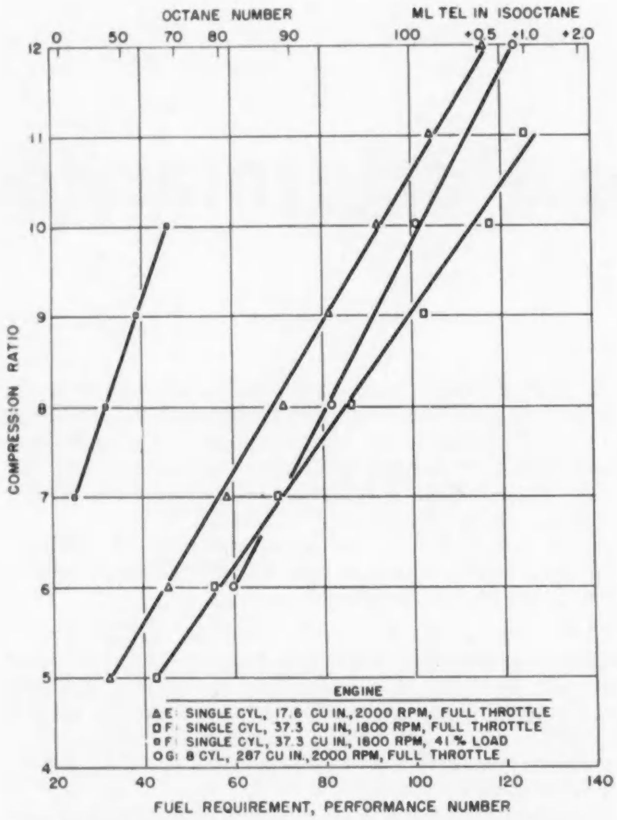


Fig. 3—Test data show a fairly direct relationship between compression ratio and fuel requirement at constant manifold pressure

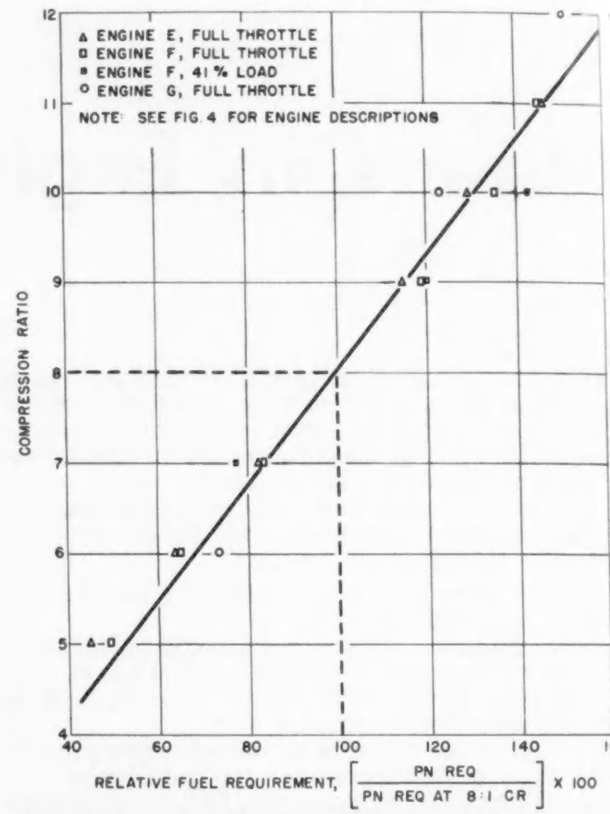


Fig. 4—Relative fuel antiknock quality varies directly with compression ratio at constant manifold pressure, with some slight variation, according to these experimental data

output with a fixed fuel of given antiknock level may vary over a wide range. This relationship may be further simplified if we consider not the absolute, but the relative fuel requirement with reference to a fixed power output.

This may be done by expressing the data previously considered, not on an absolute basis, but on the basis of relative fuel requirement; let us take as a base of 100 the fuel requirement of the engine, in terms of performance numbers, at an indicated power output of 100 imep. When this is done, it is found that, within relatively narrow limits, the relative fuel requirement for all the engines is directly proportional to the indicated power output. This relationship is shown in Fig. 2. Relative data on all of the engines, as represented by the points, fall very closely along a single straight line.

It is possible to say that for these engines the relative change in knock-limited output is, in general, directly proportional to the performance number of the fuel. Thus, if we increase the performance number of the fuel available by 15%, the knock-limited output may be increased 15%. This becomes a very convenient way of estimating the relative utility of fuels of different antiknock level under varied throttled or supercharged conditions of burning it.

This relationship can be directly applied, also, to a consideration of antiknock level of fuel required by engines at varied barometric pressure. It may also apply within the limit of probable experimental error, to changes in humidity as indicated by "dry" barometric pressure.

Permissible Compression Ratio

Another way of using the antiknock quality of a fuel is by increasing the efficiency with which it is used. This involves changing the compression ratio of the engine in which the fuel is burned.

The relation between knock-limited compression ratio and fuel antiknock quality is much more difficult to deal with. It must be handled in a somewhat empirical manner, since we do not at present express antiknock quality of any fuel in fundamental units which can be applied directly to an analysis of the engine cycle.

Furthermore, it is quite difficult, experimentally, to change the compression ratio of even a continuously variable compression ratio engine with any certainty that some of the factors affecting knock do not change in unknown ways. Changes in volumetric efficiency or engine breathing due to changes in geometry of the combustion space may influence the incidence of knock. They may disturb the experimentally observed relationship between antiknock quality and compression ratio.

An empirical approach was made to this relationship of fuel antiknock quality and compression ratio. Data have been obtained, over a range of compres-

sion ratios, on a variety of engines. For these engines it has been established that there was no significant change in volumetric efficiency with compression ratio. Performance numbers of primary reference fuel blends have been used as an index of the fuel antiknock quality requirements.

The data evaluated are from two single-cylinder engines of continuously variable compression ratio, operating under different conditions; from one of these engines when throttled to about 40% load; and also from a multicylinder General Motors Research engine in which the compression ratio was varied by changing cylinder heads.

These empirical data indicate a somewhat direct relation for each engine between compression ratio and performance number. This is shown in Fig. 3. There may be something of a more fundamental nature about this relationship as suggested by Heron and Felt:[1] "The best approximation of the duty that the fuel was exposed to . . . was the density of the air in the combustion chamber at top dead center" and "at any given volumetric efficiency the air density will vary as the compression ratio minus one."

There is, of course, no single relationship for all engines between the absolute values of compression ratio and fuel antiknock quality. This is indicated by the variation in the performance number requirements of these engines.

However, to evaluate the relative changes in antiknock quality and permissible compression ratio, we may consider the relative change in performance number accompanying changes in compression ratio. Let us take as a basis of 100 the performance number requirement for a compression ratio of 8 to 1. When this is done, there appears a simple, direct relation for all of the engines between compression ratio and relative fuel requirement within a variation of about ±10%. This is shown graphically in Fig. 4.

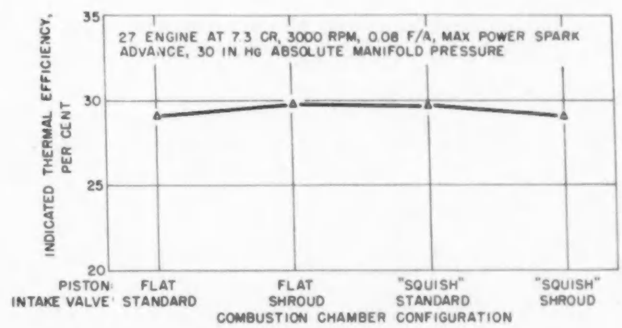
In other words, a given percentage change in antiknock quality permits a given change in compression ratio. Thus, there appears to be a fairly definite experimental relation between changes in fuel antiknock quality and permissible compression ratio, subject to some variation.

Those sets of available data showing the greatest gains in compression ratio for a fixed change in fuel antiknock quality, expressed as performance number at wide-open throttle, may be the closest approximation of the optimum relationship. Reason for such a belief is that with the higher compression ratios there may be increased opportunities for conditions that might increase the tendency to knock. It is more difficult to imagine the opposite. At present, about the only method of evaluating the existence of such conditions is by seeing how a fuel knocks in the engine.

Compression Ratio and Fuel Consumption

Compression ratio is important in determining the thermal efficiency at which an engine operates on suitable fuels. It is usually thought that the indicated thermal efficiency of an engine at fixed compression ratio is quite constant for manifold pressures above about 15 in. of hg abs (this excludes idling and extremely light load conditions) when fuel-air ratio and other engine operating conditions remain constant. This is illustrated in Fig. 5.[2] It shows substantially constant indicated thermal efficiency for a range of manifold pressures and also for different geometric configurations of the combustion volume, or different amounts of turbulence, provided the compression ratio is kept constant. In this engine turbulence was obtained by the use of shrouded intake valves for induction turbulence and by the use of "squish"-type pistons (with a depression in the piston crown) for compression turbulence.

In the theoretical analysis of an Otto cycle engine,



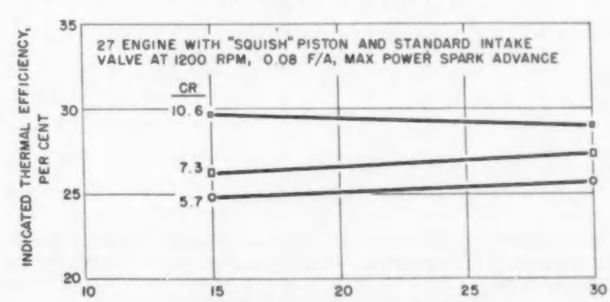


Fig. 5—Thermal efficiency remains fairly constant for a range of manifold pressures (bottom chart) and for different combustion chamber configurations (top chart), with constant compression ratio

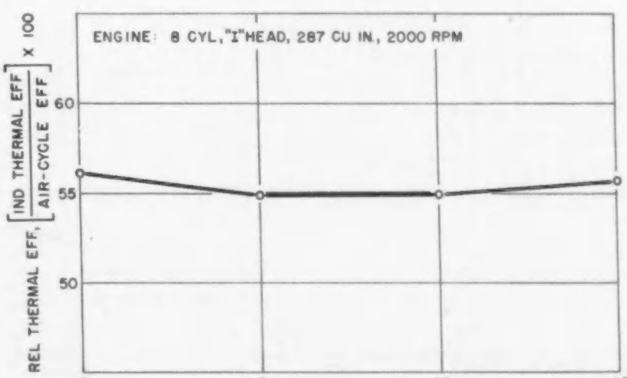


Fig. 6—Relative thermal efficiency remains fairly constant at each compression ratio, with operating conditions constant

[1] See SAE Quarterly Transactions, Vol. 4, October, 1950, pp. 455-499: "Cylinder Performance—Compression Ratio and Mechanical Octane-Number Effects," by S. D. Heron and A. E. Felt.

[2] From engine data in paper by Heron and Felt, footnote 1.

it is known that air-cycle thermal efficiency is related to compression ratio by the following equation:

$$\text{Efficiency} = 100\left[1-\left(\frac{1}{r}\right)\right]^{n-1}$$

when "r" is compression ratio and "n" is the ratio of specific heats (for which a value of 1.4 is commonly used).

It has been found that when the compression ratio of a well designed engine is increased, the gain in indicated thermal efficiency realized closely follows those predicted by a theoretical analysis. Data from the General Motors Research engine over a compression ratio range from 6 to 1 to 12 to 1 have shown that at each ratio, with other operating conditions constant, the relative thermal efficiency, or the ratio of actual to air-cycle efficiency, remains fairly constant. Thus the gains predicted on a theoretical basis are actually realized. These relative thermal efficiency data are shown in Fig. 6.

From these relationships it may be concluded that the determining factor in efficiency is compression ratio. A fixed percentage change in antiknock quality permits a given change in compression ratio. Consequently, performance number may be related quite simply to efficiency for varied compression ratio.

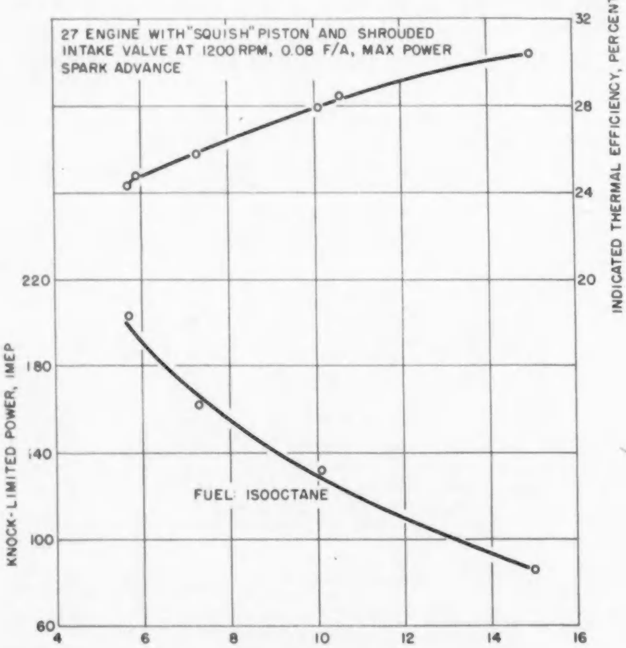


Fig. 7—Knock-limited power decreases and thermal efficiency increases as compression ratio goes up. These data show that a compression ratio increase from 5.7 to 1 to 15 to 1 lowers power more than 50% and boosts thermal efficiency about 25%

Magnitude of these gains in knock-limited thermal efficiency also may be translated directly into terms of power output. As compression ratio is increased, an engine burning a fixed amount of fuel and air becomes more efficient and more power is obtained.

The increase in knock-limited power accompanying an increase in performance number is several times as great by the supercharge method as by the compression-ratio method. By the supercharge method, however, it has been shown that there is little change in indicated thermal efficiency with variation in output.

Absolute Power and Economy Values

We have considered the changes in knock-limited power accompanying changes in relative fuel quality, with varied supercharge or throttling, and also changes in knock-limited compression ratio and hence power and economy accompanying changes in relative fuel quality. These relationships are very important because they indicate the potentialities of increases in antiknock quality with a given engine design. But they do not indicate absolute values of what can be obtained in the way of power and economy with a fuel of fixed antiknock quality.

The absolute values are a matter of compromise with what is desired in the way of power at the expense of economy, and vice versa. The general conclusion is that to use efficiently a fuel of fixed

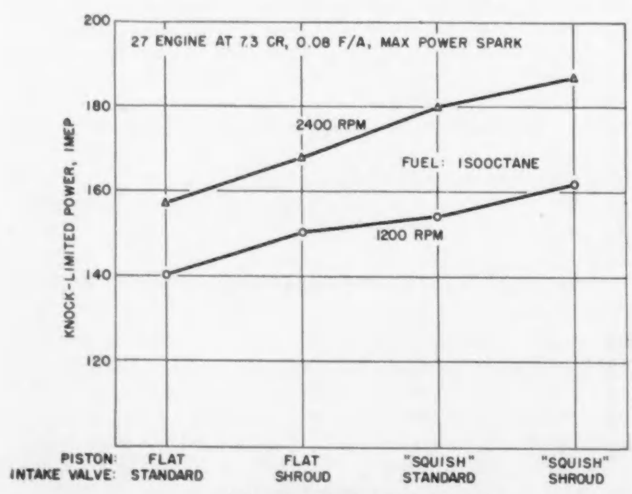


Fig. 8—Combustion chamber shape can make a difference of from 15 to 20% in knock-limited power

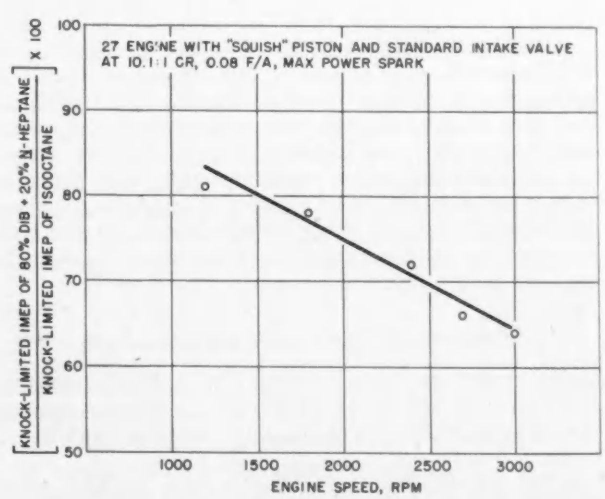


Fig. 9—Relative value (in terms of knock-limited power) of a sensitive fuel decreases as engine conditions become more severe

antiknock quality, use it naturally aspirated at high compression ratio at the expense of power output; to get high power output, operate at low compression ratio and high manifold pressure at the cost of lower thermal efficiency.

This general principle is illustrated by the data shown in Fig. 7.[3] Here, the knock-limited power for a constant fuel (which is iso-octane of 100 performance number), and also the indicated thermal efficiency on a nonknocking fuel are plotted against compression ratio. As the compression ratio is increased from 5.7 to 1 to 15 to 1 the power at knock-limited manifold pressure that may be obtained with a given fuel decreases more than 50% and the thermal efficiency increases about 25%.

The absolute values of knock-limited power are also a matter of engine design, as shown in Fig. 8. The data show that it is possible to have variation of from 15 to 20% in the supercharged, knock-limited, absolute imep with a constant fuel at constant compression ratio and engine efficiency, as the configuration of the combustion chamber volume is changed.

Relative Antiknock Values

We have dealt only with primary reference fuels, since these are the standards of reference and define all scales presently used for the measurement or evaluation of the antiknock quality of fuels. The antiknock quality of other fuels is defined in terms of these reference fuels, by making comparisons under certain engine operating conditions.

The relative antiknock values of some fuels change, however, depending upon the engine operating conditions under which they are compared. Most commercial fuels are "sensitive" or have a decreased relative antiknock value when they are used in engines under operating conditions resulting in higher temperatures probably of the "end-gas" in the combustion chamber prior to the arrival of the flame. This fact complicates the evaluation of the potentialities of these fuels, because their rating varies with engine conditions. Obviously, their rating should most properly be defined under conditions similar to those under which they are used commercially.

To get an idea of what these variations in performance number rating may be, it is convenient to examine some data obtained with a reproducible sensitive fuel consisting of a mixture of 80% diisobutylene and 20% n-heptane. Such fuel mixtures have been proposed as standards of "sensitivity" or as a means of measuring engine severity. But for the present purposes, this reproducible fuel may be regarded simply as a "sensitive" fuel. Its Research rating is 97 performance number (99 octane number) and its Motor rating is 63 performance number (84 octane number).

This fuel may show a variation in its rating (or its comparison with the standard reference fuels) as the speed of the engine in which it is used is varied. As the speed increases, the relative value may decrease, or the engine is said to become more severe.

As a specific example, Fig. 9 shows the approximate performance number rating (or the knock-limited imep to be obtained from this 80% diisobutylene mixture relative to the imep with iso-octane) of this fuel as a function of engine speed at knock-limited manifold pressure; other engine conditions are constant. As the speed increases, the relative value of the fuel in terms of knock-limited power decreases . . . . the engine conditions become more severe.

Effect of combustion-chamber geometry or turbu-

Continued on Page 43

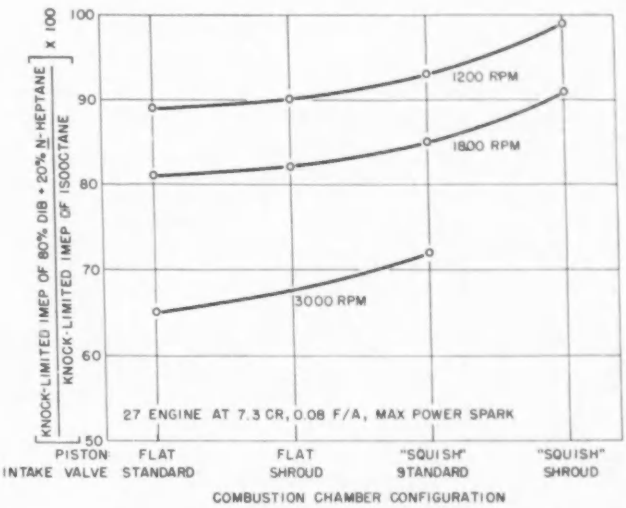


Fig. 10—The more the turbulence in a combustion chamber, the greater the relative knock-limited power of a sensitive fuel

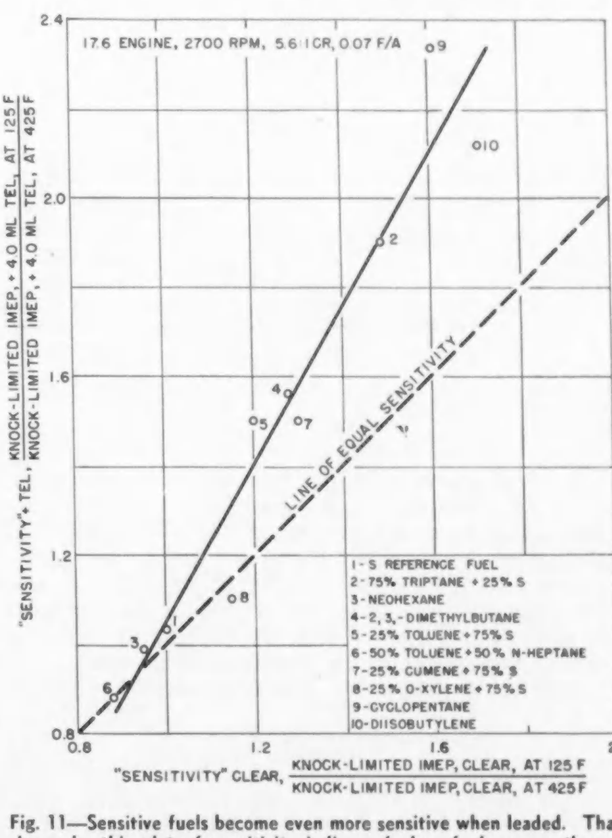


Fig. 11—Sensitive fuels become even more sensitive when leaded. That's shown by this plot of sensitivity indices of clear fuels versus those of the same fuels containing 4 ml tel per gal

[3] From paper by Heron and Felt, footnote 1.

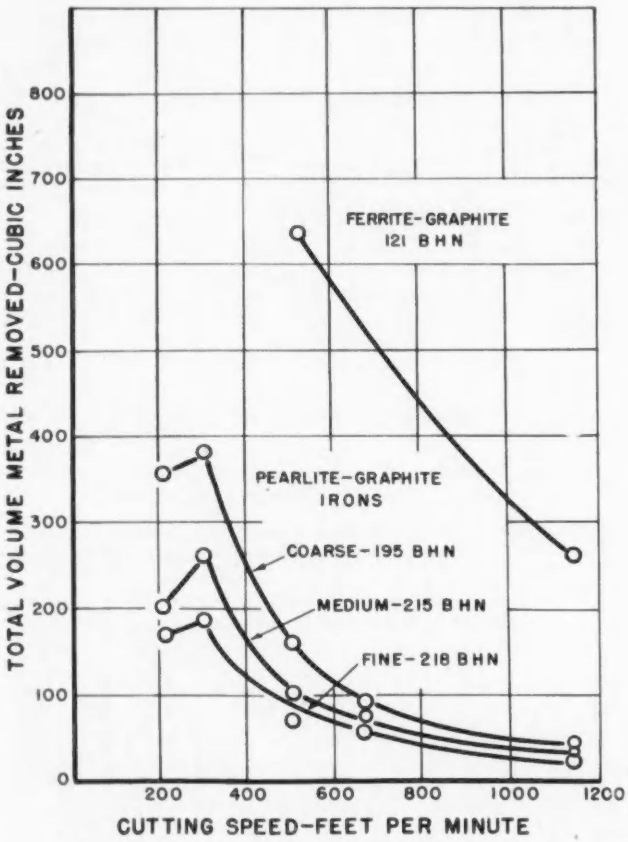


Fig. 1—Tool life in cubic inches of metal removed to produce 0.030 in. wear on carbide tools versus cutting speed. Operation in this case is carbide face milling of gray cast iron

Microstructure Holds Key

THE metal-cutting industry can get machining rates 10 times faster and tool life up to 50 times greater than those it now gets. This is possible with certain cast irons and steels if two things are done: (1) getting the right metallurgical structure in the work piece, and (2) using a compatible cutting tool.

Engineers have given lots of thought to physical property requirements in selecting work material; but machining properties have been sadly neglected.

Choose Material—Then Its Form

First step in the selection job is to pick the kind of material—such as cast iron, ductile iron, cast steel, or a nonferrous alloy. Then there still remains a choice in selecting the exact form of the material to be machined. For example, if medium carbon alloy steel is needed, the engineer should ask himself questions such as these: Which SAE form should I select? What should be the heat-treatment? Can I use a sulfurized steel? If cast iron is chosen, what structure should be used for best machinability?

A given cast-iron analysis may be cast and then treated to give differences in tool life of 50 to 1 at a constant cutting speed, or differences of 10 to 1 in productivity for a given tool life. Converting from high-speed steel to carbide tools offers possibility of five to 25 times increased productivity. Even with a single steel, tool life differences of 10 to 1 can exist. That's if you choose the right metallurgical structure through suitable annealing, and if a suitable carbide grade is selected for that particular microstructure.

Carbide cutting tools probably have increased production rates more than anything else. They have been used extensively on operations such as milling of cast iron, turning on turret lathes, and large turning jobs. Only limited use has been made of them in drilling, reaming, tapping, and gear generating.

Considerable investigation now is under way on operations such as carbide drilling. Chances are good that it will replace high-speed steel drilling on many applications.

There doesn't seem to be too much experimental activity on automatic screw machines. Such machines use many forming operations, which are not suited to carbide tooling. This may call for machine redesign with high enough speeds and rigidity for carbide use. Or perhaps what's needed is a changeover from forming to profile generating. In fact, that seems to be the trend in turning larger parts on automatic lathes.

Machinability of cast irons and wrought steels depends on microstructure rather than chemical composition or hardness. Many data have been accumulated to demonstrate this.

Microstructure of a casting depends on several things: the initial cupola charge, pouring temperature, mold condition, and cooling rate. Specifying chemistry alone doesn't guarantee a specific metallurgical structure in the work.

Range in structures of various commercial irons is shown on pp. 40, 41. Relative tool life in carbide milling of these structures is shown in Figs. 1 and 2. At 300 fpm, the coarse pearlitic iron gave twice the

To Speedier Metal Cutting

BASED ON PAPER* BY

Michael Field and Norman Zlatin, Partners, Metcut Research Associates

* Paper "Increasing Productivity in Production Machining," was presented at SAE Annual Meeting, Detroit, Jan. 9, 1951.

tool life of the fine pearlitic iron. The annealed ferritic iron was even better.

For a tool life of 200 cu in., the fine pearlitic iron would be cut at 300 fpm, the coarse pearlitic iron at 450 fpm, and the annealed ferritic iron could be machined above 1200 fpm.

These data show it is possible to use speeds and production rates far greater than those found in present practice. It is a must to control structure closely with high speed, these curves reveal. Small variations in structure can greatly shorten tool life.

Fig. 3 emphasizes the need for control. It shows the effect on tool life of two common cast-iron constituents—steadite and carbide. Steadite is an eutectic composition of iron, phosphorous, and carbon. Steadite in amounts under 10% has no appreciable effect on machinability in the ordinary speed range. But free carbide, even in small quantities, drastically reduces tool life. At 300 fpm, 5% free carbide in a pearlitic mixture reduces tool life by more than two thirds.

Carbide turning, like carbide milling of cast iron, varies considerably with different structures.

More Machinability, Less Strength

Remember that the more machinable structure in cast irons of the flake graphite type has the poorer physical properties. This may be considered a drawback with such irons. But a recent study of cast-iron components in a motor car engine showed that at least 75% of the parts could be annealed and still maintain adequate strength.

In certain applications, loss of strength from annealing flake graphite iron cannot be tolerated. The ductile or nodular graphite cast irons are a natural for such applications. They are made by adding an innoculant (usually magnesium or cerium compounds) to the ladle.

Ductile irons are cast much like gray or flake

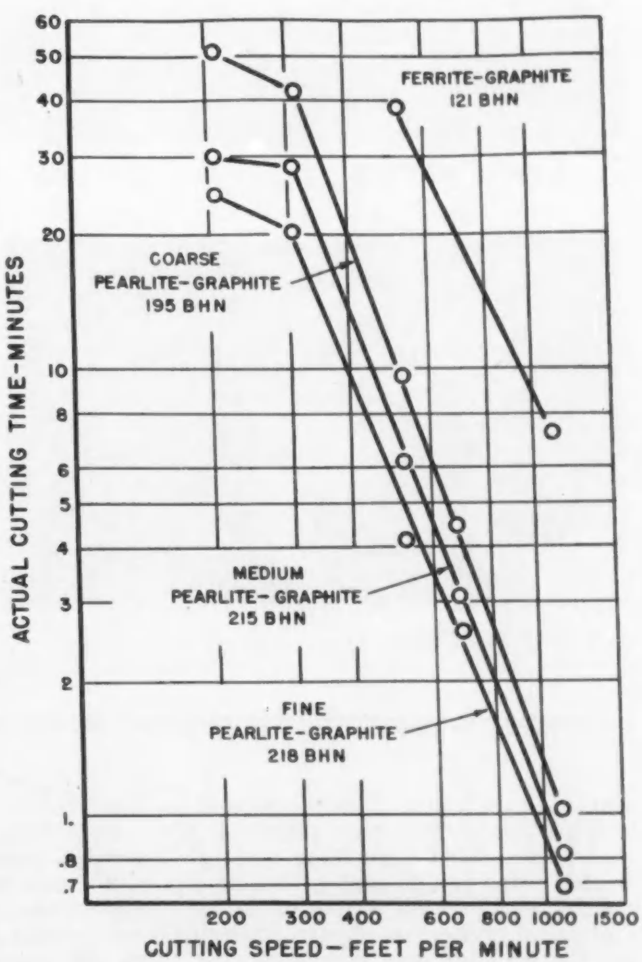
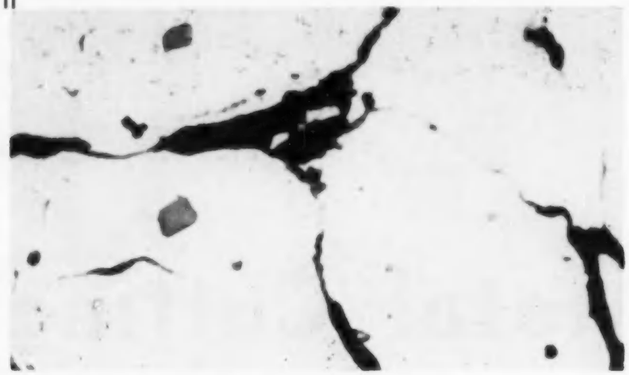
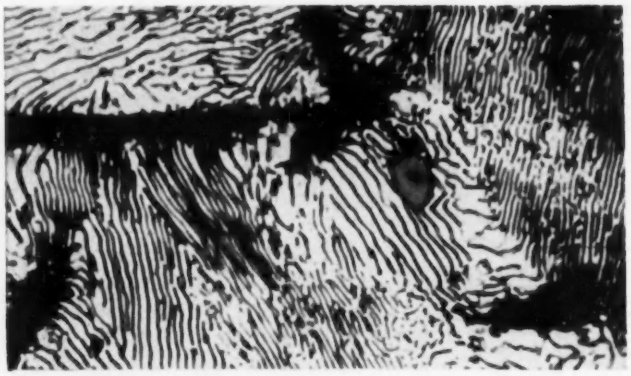


Fig. 2—These are the same data in Fig. 1 plotted to show tool life in minutes to produce 0.030 in. wear on carbide tools versus cutting speed



1. Ferrite and flake graphite

These cast-iron in order of



2. Coarse pearlite

3. Fine pearlite

You get the first structure, containing ferrite and flake graphite, by complete annealing. The second, a coarse pearlitic case iron, comes from fairly slow cooling in the as-cast condition. The third structure is the same analysis cooled more rapidly to produce a fine pearlitic case iron.

Fourth photomicrograph is a structure consisting of fine pearlite with steadite. Steadite is common in cast irons with more than 0.1% phosphorous.

Next is an iron with a fine pearlitic matrix together with some free iron carbide. Carbide is extremely hard and cuts tool life to one-third. Rapid cooling yields small percentages of free carbide. Alloys such as chromium and vanadium in cast iron accelerate free carbide.

Adding alloys such as chromium and nickel produce high-strength flake graphite irons. They have an acicular or needle-like structure, shown in the sixth photomicrograph. Shown in the last structure is a white iron consisting of fine pearlite and free carbides, obtained by a rapid chill. This iron is practically unmachinable.

These microstructures are 1000X photomicrographs.

graphite cast irons. There is no size limit to ductile iron castings. The high physicals stem from the spheroidal rather than flaky form of free graphite. Ductile irons can be cast with a matrix of all pearlite or pearlite plus ferrite of varying proportions.

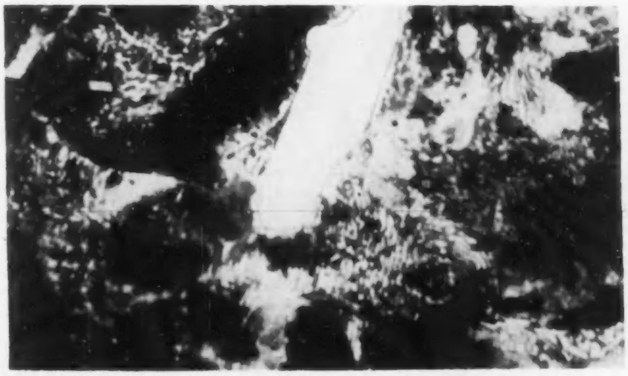
Physical properties of even annealed ductile irons are higher than the strongest cast iron. At the same time, annealed ductile iron with the ferritic structure anneals as well as the sofest gray (flake graphite) iron. Thus ductile iron offers high production rates combined with the physical strength of the strongest gray iron.

Ductile irons have tremendous potentialities in the automotive and related fields. We feel this iron will find wide use in the annealed form containing almost all ferrite, or in the lowest physical as-cast form which would contain a high proportion of free ferrite. Ductile irons will bring castings with much

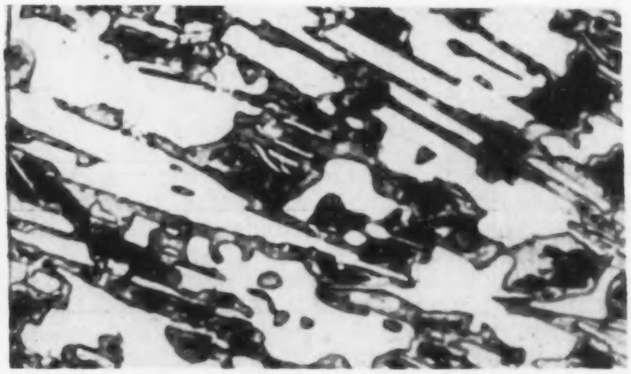
structures are arranged decreasing ease of machinability

4. Pearlite with 5% steadite

6. Acicular cast-iron matrix



5. Pearlite with 5% free carbide



7. White iron with pearlite and free carbide

better machinability than that of present castings. And ductile irons will give high tensile strengths, greater rigidity, and high ductility. (Gray iron castings have practically no ductility.)

Machining Wrought Steels

Microstructure also affects machinability of wrought steels. Preliminary tests in turning SAE 8640 steel show the big differences in tool life when cutting steels annealed to produce different microstructures. Even plants specifying similar heat-treat conditions get widely differing microstructures. Reason: Annealing and normalizing practices differ from one plant to another and usual furnace annealing procedures do not adequately control cooling rates.

You need uniformity to get consistency in machining. You'll get it only by insisting on heat-

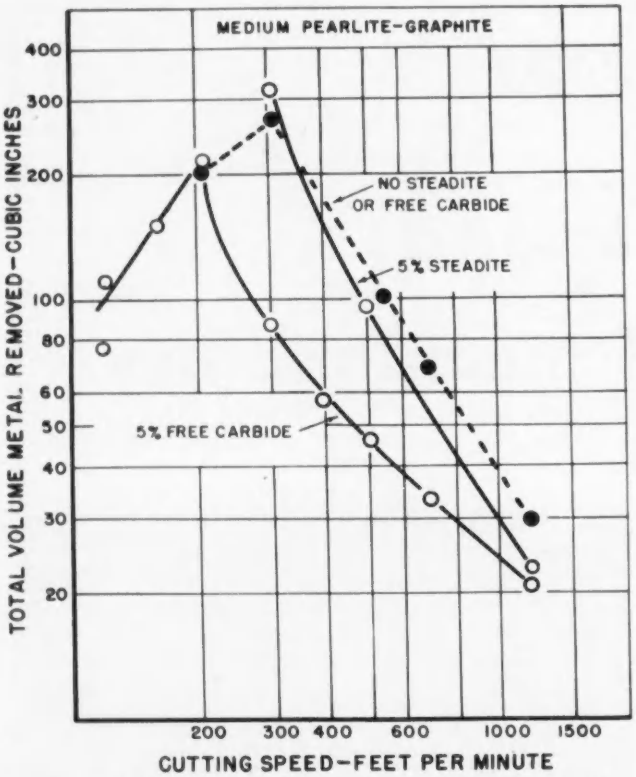


Fig. 3—Tool life in cubic inches of metal removed to produce 0.030 in. wear on carbide tool versus feed per tooth

treating to definite microstructures and hardness levels.

Turning tests were made on 8640 rolled steel bars, heat-treated in various ways to get different structures. The results are considered indicative of medium carbon alloy steels in general. These steels were turned on a lathe with both high-speed steel and carbide tooling. Tool life was shown to depend on two things—microstructure and grade of carbide.

Hardness Not Sole Criterion

The tool life versus cutting speed curves for the general purpose grade of steel cutting carbide 78B are shown in Figs. 4 and 5. Tool life appeared to be proportional to hardness with this carbide grade. Exception was the tempered 219 Brinell structure, which was as soft as the annealed structure, but machined far poorer.

At 300 fpm, the annealed structure (consisting of 75% pearlite and 25% ferrite) gave twice the tool life as did the tempered. With the harder grade of steel-cutting carbide (grade 78), a structure 40 points harder than the 75% pearlite-25% ferrite machined better.

This shows that hardness cannot be used as the sole criterion. It should be only one of the guides in setting up machining conditions. Note that it is possible to choose an annealed structure and carbide grade which will permit machining at much higher speeds than those in present practice.

Cutting properties of the lower carbon steels, such

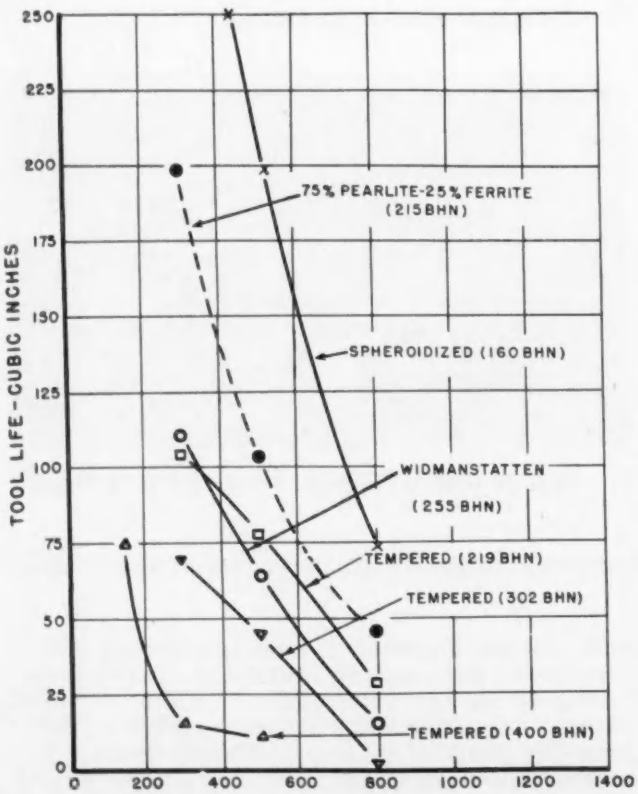


Fig. 4—These are results from turning SAE 8640 steel. It shows tool life in cubic inches of metal removed to produce 0.015 in. wear on carbide tooling versus cutting speed

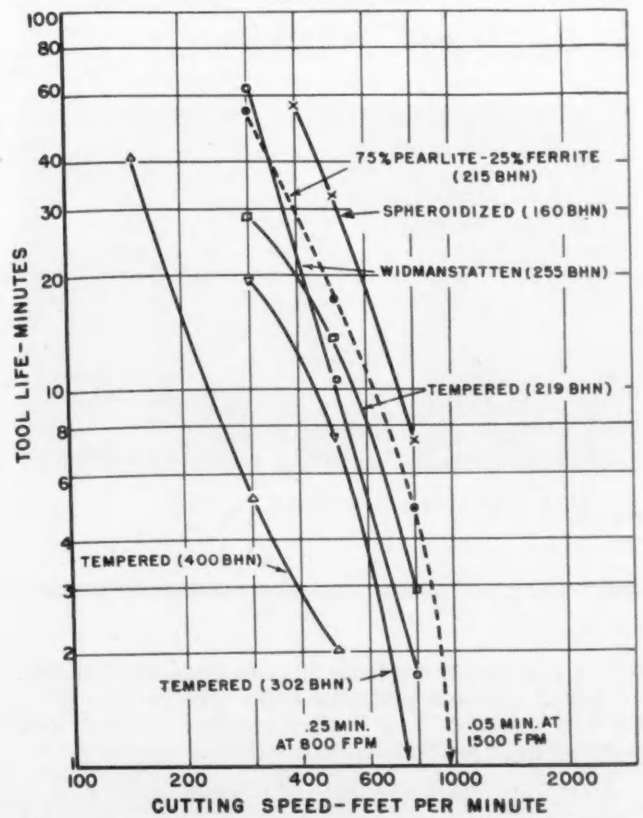


Fig. 5—The same data on turning SAE 8640 steel shown in Fig. 4 are plotted here to show tool life in minutes to produce 0.015 in. wear on carbide tool versus cutting speed

as SAE 8620, are superior to those of SAE 8640. Thus even higher speeds are possible. High tool life is available at speeds up to 800 and 900 fpm. In fact, such speeds are being used in turning an automobile hypoid pinion.

The big gain in cutting speed and tool life from converting from high-speed steel to carbide tooling is shown in Fig. 6. Results are from machining a tempered and annealed form of 8640 steel. The high-speed steel tool was run to destruction; the carbide tools were removed after 0.015 in. flank wear. Ordinarily, carbide tools could be run to 0.030 in. flank wear. This would shift the carbide curves far to the right.

A six to tenfold production increase accompanies the higher speed and tool life in converting from high-speed steel to carbides.

If there is one lesson to be learned from machining research to date it is this: On production set-ups run week after week on the same operation, data must be obtained relating machining properties to work material and structure. You cannot get the best machining conditions without this information.

Acknowledgment

The majority of the charts and illustrations have appeared previously in the "U. S. Air Force Machinability Report-1950" and were prepared by Metcut Research Associates for the U. S. Air Force under a subcontract with Curtiss-Wright Corp. The experimental results on the milling of cast iron with carbides is shown through the courtesy of the Cincinnati Milling Machine Co.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

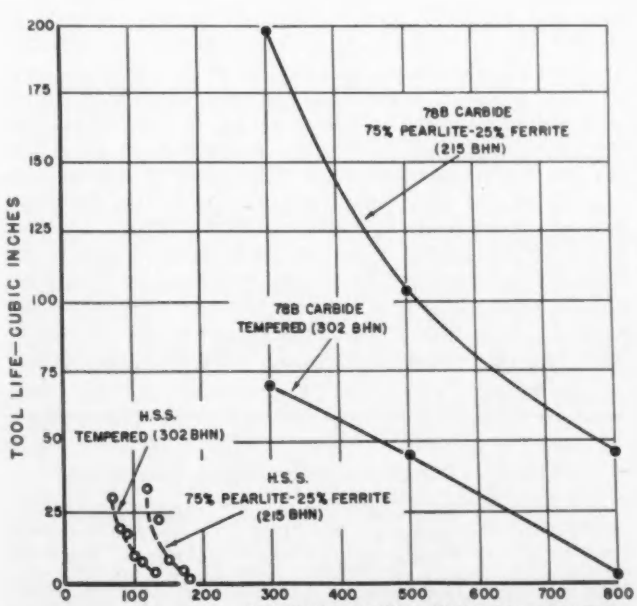


Fig. 6—Compared here are turning of SAE 8640 steel with high-speed steel and carbide tools. Life of the high-speed tool came to an end with a complete nose breakdown. Tool life end point for carbide was 0.015 in. wear

What Antiknock Means in Performance

Continued from Page 37

lence or "squish" upon the relative value of this fuel is especially interesting, when comparing its relative knock-limited output with compression ratio and with other engine operating conditions constant. Such a comparison is shown in Fig. 10.[4] In general, with more turbulence or "squish" in the combustion chamber, the relative value of this sensitive fuel increases.

This form of "mechanical octane number," the potentiality of obtaining greater performance from fuels of given antiknock level by means of engine design, may be considerably exploited in the future. A good deal of work is needed to evaluate those factors which cause an engine to take greater relative advantage of some sensitive fuels.

Effectiveness of Tel

Some attention should be given to the potentialities of tetraethyl lead because of its almost universal use in gasoline to enhance antiknock quality. Again, it is most convenient to consider its effectiveness or utility in terms of performance number. An evaluation of the effectiveness of tetraethyl lead in blends of iso-octane and n-heptane has shown that, regardless of the antiknock level of the blends, the per cent increase in the performance number of the base for the addition of a given amount of tetraethyl lead is a relatively constant amount.

This relationship does not appear to be confined to primary reference fuels but seems to hold approximately for most saturated fuels such as the pure paraffin and naphthene hydrocarbons. Thus the absolute usefulness or utility of tetraethyl lead, in terms of performance number increases as the performance number of these fuels increases.

This conclusion does not hold for some other fuels such as certain "sensitive" olefins and aromatics, where the effectiveness of tetraethyl lead seems to depend upon molecular structure. However, for fuels of greater "sensitivity" it can be said that, in general, tetraethyl lead becomes more effective in them under mild engine conditions.

This is illustrated in Fig. 11, using data on a wide variety of fuels ranging from insensitive iso-octane to cyclopentane, an extremely "sensitive" fuel. As an index of "sensitivity" we have used the relative knock-limited imep or approximate performance number at an air temperature of 125 F as compared with that at 425 F. This "sensitivity" index of the clear fuels is plotted against that of the same fuel containing 4 ml tel per gal. It appears that the more "sensitive" fuels become even more sensitive when leaded; or in other words, that the performance number gains to be made by using "sensitive" fuels in mild engines are even greater when these fuels contain tetraethyl lead.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

[4] From paper by Heron and Felt, footnote 1.

How CAA Forecasts Air

SINCE air traffic is ever-increasing, the old facilities are constantly being outgrown and so must be expanded or new ones provided. If the CAA is to keep up with these increases, it must be able to estimate the number of airline passengers, the amount of air mail and air cargo that will be flown 5 years—or 10 years—or more—from now.

The method of predicting how many airline passengers can be expected in the future will be used to show, in general, how such forecasts are made.

Making a Forecast

Before trying to predict the number of airline passengers that will be flown in future years, it is desirable to study the past: so we go back to 1945, when the forecaster had several facts about airline passenger traffic that gave him a "performance basis" on which to estimate, such as:

1. Airline passengers had increased from 159,751 in 1929 to 1,876,051 in 1939. This is more than a 10-fold increase for a 10-year period.
2. After a temporary readjust downward because of war conditions, passenger traffic increased rapidly from the 1939 level to 4,668,466 in 1944.
3. During the war the demand for air transportation exceeded the supply. It was evident that a reservoir of passenger traffic was awaiting the development of the necessary facilities and that air travel, like long-distance telephoning, had achieved an enlarged acceptance by the American public.

These facts indicated that a rapid increase in airline passenger traffic would be likely during the postwar period. This conclusion was reinforced by other factors. In 1945 it seemed reasonable to expect a rapid increase in airline passenger traffic for such reasons as:

1. Possible reduction in fares.
2. Certification of additional communities by C.A.B.
3. Adequate service to certificated communities when equipment became available.
4. The relationship between airline passengers and national income.
5. The addition of new services, such as air coach.

By 1948 the forecaster had additional data on airline passengers that could be used. In other words, the 1945 passenger estimates could be analyzed on a performance basis to determine how well the prophecies had withstood the test of time. This review of passenger forecasts led the CAA to select one of the existing estimates rather than to create a prophecy of its own. The one selected was an estimate of 20,000,000 passengers by 1955, which originally appeared in the 1945 booklet, "Civil Aviation and the National Economy." This 20,000,000 estimate is conservative and could be attained prior to 1955.

There will be around 16,000,000 passengers in 1950 if the last six months of the year continue the 8% increase over the same period in 1949. Even though the forecast of 20,000,000 is exceeded by 1955, the amount of the increase is likely to be a relatively small percentage of 20,000,000. For a national estimate, it is really not important that the 20,000,000 figure be exactly correct. It is only important that the volume of traffic in 1955 be near enough to 20,000,000 so that it will not create significant differences in the requirements of civil aviation.

The 1950 census definitely shows that large places are getting larger, while smaller communities are experiencing little change. A review of air commerce traffic data for the past several years definitely proves that the bulk of the traffic increase has occurred in large metropolitan districts and the increase in traffic flow between communities has been largely limited to more traffic along the same routes that already have the bulk of the passenger traffic. It is likely that this pattern will continue, with the very large metropolitan districts increasing

Table 1—Domestic Air Commerce Predictions

Year	Number of Enplaned Passengers	Enplaned Cargo, tons	Mail Originated, tons	
			Letters	Parcel Post
1949	14,859,000	169,400	310,300	3,600,000
1980	39,563,000	1,517,500	384,800	4,700,000
1980 increase over 1949, %	166.3	795.8		29.5

Traffic Potential

BASED ON PAPER* BY

Frederick B. Lee, Deputy Administrator for Program Planning, CAA

* Paper, "Air Transportation and What Is the General Future," was presented at the SAE National Aeronautic Meeting, Los Angeles, Sept. 29, 1950.

their traffic at a faster rate than the national average and the other communities following at a slower pace.

While CAA has, so far, limited its forecasts to 1955, some estimates have been made for the years beyond. The most recent and complete air commerce forecasts are those in the Port of New York Authority study, "Air Traffic Forecasts." These predictions are for 1980, and are shown in Table 1.

Facilities

To provide facilities as needed to accommodate this anticipated growth of air commerce, the CAA has embarked on an air navigation facility program that is designed to simplify air navigation under all weather conditions and to eliminate significant delays to the movement of aircraft in adverse weather conditions. The system of navigation coming into use during the present time and the ultimate system that is being developed by the Air Navigational Board is the new common air navigation system that will serve navigation and traffic control needs of all classes of civil and military aircraft from the civil light plane to the military jet fighters and bombers.

The old air route system was built around the familiar four-course radio range, which operated on the low and medium frequencies. This system has too many limitations to meet the air traffic demands that are forecast for the future. In the first place, the limitation of four courses severely restricts the number of air routes to and from a given location, and the atmospheric disturbances that are common in the low- and medium-frequency bands greatly reduce the effectiveness of those ranges.

The CAA is installing some 400 very-high-frequency omnidirectional ranges to provide the multiple air routes required by the growing air commerce of our nation and to provide static-free, reliable navigation service under all weather conditions. Concurrently with the transition from low and medium frequencies to the very high frequencies for navigational purposes, all communications between air and ground are undergoing a similar transition and we expect virtually all such communications to be on very-high-frequency channels by 1953. All CAA facilities and most large aircraft already are equipped with very-high-frequency communication equipment and the use of these static-free channels is increasing rapidly year by year.

The CAA is undertaking a large program of the installation and use of surveillance and precision radar at the major points of air traffic concentration. The full effect of radar in increasing the safety of operations and decreasing the delay experienced in air traffic can only be estimated. The experience of the Air Force and the CAA with radar control of congested areas has led, however, to the conclusion that all air traffic that is forecast for 1955 can be handled with safety and efficiency and without significant delay on the basis of completion of our present program of new air traffic and navigation facilities.

The CAA has long been concerned with the air traffic control problem that is created by the air commerce pattern and has been taking constructive steps to expedite the movement of aircraft and to eliminate delay, which is the evil of congestion. The air traffic control system showed remarkable improvement from 1944 to 1949, as indicated by the fact that the average delay per instrument approach in 1949 was only one-third that experienced in 1944, notwithstanding that the number of annual instrument approaches increased three-fold during that period. This increase in efficiency of air traffic control is due to numerous factors, but the most significant one is the widespread installation and increasing use of the instrument landing system, which permits precision approaches to be made, with resulting shorter intervals between approaches than was possible with the prewar range station type of approach. Thus, we have already seen the dramatic effect of the widespread use of only one element of our new common airway system, now coming into being.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Cost-Saving Tips on Blast

EXCERPTS FROM TALK* BY

Max R. Wiard, Campbell, Wyant & Cannon Foundry Co.

* Talk "Operation of Blast Cleaning Equipment," was presented at meeting of Shot Peening Division, of the SAE Iron & Steel Technical Committee, June 28, 1950, Hagerstown, Md.

THE foundryman who wants to get castings clean at lowest blasting costs has to keep an eye on blast cleaning equipment, methods, and materials.

Before and during the first part of the war, we used steel liner plates in the back walls of the blast. These plates would last about one week. At the end of the war, we started using rejected armor plate. We bought many carloads of this as we found that this plate would last about three weeks.

For the last year or so, we have been using rubber sheets in the back wall. Although they are more expensive in the initial installation we find that these last about 30 weeks. As the cost of the rubber sheets is approximately three times that of the steel plates that we used, this shows a considerable saving in the cost of the material used in this back wall, as well as reducing the labor of installation. Also the shot hitting this rubber back wall will not break up as fast as shot hitting the armor plate.

One of the most important parts of the blast is the separator. Any blasting equipment that is to be purchased today will have a good separator, provided you operate it the way it is supposed to be operated. If the separator is not taking the sand out of the shot, you immediately run into cleaning troubles because you cannot get your castings clean. To have the maintenance men operate this separator and the rest of the blast the way it should be operated, it is advisable to have the manufacturer of the blast equipment send an engineer or a service man to your plant to instruct your maintenance men.

An unsatisfactory operation you may not recognize is that the separator is taking too much of the fine shot out and your cost of operation is going up, while you still may be getting a satisfactory cleaning. In fact, if this separator is not checked regularly, you are liable to have a considerable amount of your usable shot being hauled away to the dump.

Another important item is the positioning of your wheels for the shot pattern to hit the work. If you have an old-time blast operator operating your machine, you have probably forgotten all about this problem. But even then, it will pay to check the blast pattern every so often to be sure that all the shot possible is hitting the work.

Our method of checking this pattern is to stop the work carry chain at the index point in front of the wheel, then hang a pine board on each hook in the position of the work, using two or three cast pigs fastened to the bottom of the board as weights to keep it from moving, and then bringing the wheel up to speed before feeding the shot into the blast wheel for approximately 10 sec. There are other methods of checking this blast pattern, but we can certainly see where the shot is hitting the board or would hit the work by this method. Besides checking this regularly for blast pattern, you should also check the index point of the work carrying chain as this point may move, because of the stretch or wear in the chain or some other conditions. It is just as important that you check the position of the blast pattern on a single-wheel machine as it is on a multiple-wheel unit because if the shot does not hit the work, you do not get the full value of the shot cleaning out of your blast.

You certainly should check your pattern very carefully if you switch from iron to malleabrasive or steel shot and you should also check the pattern every time you change the size of the shot used in the blast. We find that when we change to a different type of shot, the blasting area moves as far as 8 or 9 in. on the work.

Probably the most important item in operating a blast, at least from the cost standpoint, is the shot. Here we are talking only about the shot being used and not the relative merits of different shot.

When you talk about shot costs and efficiency of operation, you should use a cost figure that will be consistent and represent the cost of cleaning. A quick and easy way to figure this cost is to take the total cost of the shot used for any number of days and divide this cost by the total tons of castings cleaned during the same period.

In many plants this will be a satisfactory method for figuring cost of blasting and also the efficiency of the blast operation, provided the castings make just one pass through the blast. But we find at our plant that many of the castings are reblasted either after welding or after the castings have been stored and require recleaning before shipment. In

Cleaning

fact, some of the castings were blasted three times before they were finally out of the plant. The shot consumption for the reblasting would be within practical limits the same as for the original blasting. In order to know that the blast is operating efficiently, we should consider the tonnage passed through the blast whether it is original or reblast castings.

After running tests and keeping records of all the shot used and the total tons cleaned, we found that the shot cost for cleaning on the cylinder-block blast was about one-half the cost per ton of our annual cost per ton figure. As mentioned before, this was due to reblasting of some of the castings.

While checking into the method of figuring the cost per ton for cleaning castings and trying to explain the reason for the big difference between the test run operating cost and the total annual cost figure for cleaning castings, we discovered that there were many things in our blast operations that were not satisfactory. We noticed an average amount of spillage of shot caused by leakage from the blast cabinet on the floor and in the pit of the blast and we also happened to notice that some of this had been swept up and thrown into a Roura refuse hopper which was used in plant cleanup. Realizing that this Roura hopper was going to the dump, we immediately took steps to find out how much shot we were losing by this method of cleanup.

We had just relocated a spotblasting unit adjacent to our main blast with a result that we had a shot separator left over from this unit. We set up this separator system in an area at the rear of the plant and orders were given for all refuse hoppers from the shotblast equipment areas to be brought to the separator and the material passed through the separator before going to our refuse dump.

We certainly got a surprise when out of the first Roura hopper we salvaged 22 bags of shot. After inspecting this shot recovered, we estimated that at least 70% was practically new shot, and the rest was still good-sized shot with lots of life left in it.

We then started checking with our supervision and shotblast operators to plug all the loop holes where shot could get away from the units. One of these was rather surprising. There was a 6-in. opening in the floor into which the shotblast operator had been sweeping dirt and shot for a considerable time. Originally, a chute from this opening was connected back into the blast but, going below the floor, we discovered this opening now dumped directly on a refuse belt which carried the material to a refuse hopper and then directly to the dump. This hole was plugged permanently.

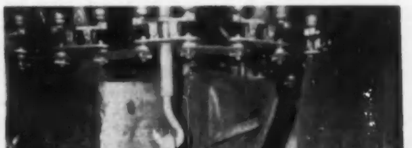
After discovering these conditions of operation, and as the question of whether we should use different shot (such as malleable, steel, or wire shot) kept coming up, we decided to run a continuous test on one of our blasts. We also decided to keep track of all of the shot used and also the maintenance costs. In March of 1949, we set up a system for keeping track of every ton of shot we ordered, where it was used and complete records on all of our blasts.

When we started this shot test, we did not jump

Blast Cleaning Cylinder Blocks

1. Cylinder block castings enter the blast cabinet.

2. Inside the cabinet, shot blast cleans surface of castings.



3. Clean castings leave the blast machines.

into new steel shot or malleable shot. We decided to get a consistent operation with the regular iron shot that we were using at that time.

One of the first things we did was to go over all of the separating equipment and also go over all of the wheels and liner plates. The next step was to check the flow of shot to the blast wheels and, where the amount of shot fed to the wheel in terms of pounds per minute was low, it was brought up to the blast manufacturer's specifications. We also checked air velocities in pipes where we thought readings might be of value. Then we started a system for recording the shot added to the blast and also recorded all materials used and time spent repairing or working on the blasts.

At the end of the first two weeks, we tabulated some of these figures and found that we could not check the results. It took another month to sell the blast operator the idea of the test and to get the system working. We then felt we were getting a true picture of the test.

We certainly could have made a wonderful showing in malleable, steel, or wire shot if we had started right out with one of these new materials on these tests. Our shot consumption dropped off just by our watching, adjusting, and keeping track of what was going on in the shotblast operations.

We have now been running this shot test for over a year and we estimate that during this time we have had a saving in shot costs of many thousands of dollars.

There are several things in operating the shotblast that make any tests, at least in our plant, difficult. First is the fact that castings coming to the blast are not always the same. They may be 4-, 6-, or 8-cyl blocks. This would make a great change in the tonnage being cleaned, and we also found the shot consumption varied considerably in addition to the tonnage variation. The ideal shotblasting setup for a test would be the continual operation of the blast with the same castings and the same tonnage day after day. Of course, this condition does not exist in most foundries.

In addition to the variation in the tonnage through the blast, we find that the shape of different castings seems to have an effect on the shot life. First, the castings have curved surfaces; and second, the castings are of different hardness. Another important consideration is the additional time required to clean castings made with a different mold wash. One mold wash will allow the casting to be cleaned very easily, another will have a burn-in that is difficult to clean.

There are two ways to check the efficiency of the blast operation from the standpoint of how much shot is being used for cleaning. You can consider the pounds of shot added per wheel-hour of operation, or you can consider the pounds of shot added per ton of castings cleaned. Because of the variation in the tonnage passing through our blasts, the pounds of shot added per ton of castings cleaned would be less accurate than the pounds of shot used per wheel-hour. Although we plot both of these curves, we use the pounds of shot added per wheel-hour as an indication of how efficiently our shot is being used in the blast.

One item that was very discouraging in our preliminary test runs was the fact that one day there would be 1000 lb of shot added to the blast, the next two days there would be no shot added, and still the next day another 1500 lb would be added. Again we tried to work with the operator to keep this on a uniform basis; but this did not prove satisfactory. We rigged up a simple feeder which would keep the shot in the separator at the same height or within a high and low limit of 2 in. at all times. Although this leveled out the daily shot consumption somewhat, we still had considerable fluctuation in the amount of shot used but we noticed that the longer we used the mechanical method for feeding the shot, the more consistent our shot additions became.

We also have tumblasts and a monorail blast for sleeves. Each one of our blasts presents an entirely different problem on the shot used and also on tonnage cleaned and cost of cleaning.

Table 1 shows the results of these tests for one year with iron shot. We have not run our steel test long enough to show blade life.

Our test results are not too satisfactory. It is very difficult with so many variables to make a test run that is consistent.

There are four things that we wish to point out:

1. Just the fact that somebody besides the production department is watching the shotblast operation will save any company considerable money. No matter how carefully the production supervision tries to be, they are usually pretty well loaded with work and cannot see that the shotblast separating equipment is in A-1 shape at all times, and that the spillage of shot is kept to an absolute minimum and is returned to the blast and not discarded.

2. The use of an automatic feeder, we believe, will increase the blade life. It eliminates a slug of large shot passing through the wheels. The automatic feeder also should give a more consistent grading.

3. It will pay you to investigate the cost of rubber sheets on the back wall from the replacement costs of these sheets as well as the additional life it should give to the shot hitting this back wall.

4. It may be difficult to get the foundry to try different wash materials on molds; but from the cost angle of cleaning the casting it may be worth while to do some experimental work in your plant along this line.

Operation of blast cleaning equipment is still purely a matter of having the minimum cost of cleaning castings. In fact, we are not interested whether castings are cleaned with marbles, sand, or other materials as long as the castings are cleaned and the cost is a minimum. When we say cost is a minimum, this includes complete operation of the blast referred to in dollars and cents.

Table 1—Shot Blasting Test Data

	Blade Life Hours per set	Lb Shot to wheel per min	Lb shot per Wheel hr	Lb shot per ton Casting
Cam Blast #1	83.14	265	26	14
Cam Blast #2	171.2[a]	265	37	20
Cylinder Blast #1	49.6	490	52	14
Cylinder Blast #2	60.3		54	17
Misc. Blast #2	50	500	36	16
Heat Treat Blast	102	270	14	5.6
Sleeve Blast	48	260	56	37

[a] Short test run on new blast just put in operation.

Refiners Improve Products For Personal Aircraft

EXCERPTS FROM PAPER* BY

W. V. Hanley, Standard Oil Co. of California

* Paper "Fuel and Lubricant Requirements of Personal Plane Aircraft Engines," was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 10, 1950.

THE 80/87 octane aviation gasolines now marketed by major suppliers perform adequately in today's personal airplanes.

Not so much can be said for some current highly compounded detergent oils marketed for personal planes; their additives build deposits that lead to preignition and boost octane requirement. But additives which cannot cause preignition, yet provide cleaner engines and longer overhaul periods, are on the way.

The 80/87 octane fuel satisfies, among other requirements, the antidetonation requirements of current personal plane engines. Previous fuels without the 87-octane rich take-off rating did not suit some engines. Continued detonation—although it should not be blamed for sudden engine failures—did erode aluminum parts of combustion chambers and cause high piston ring wear.

Sudden engine failures are more likely to be due to preignition. Whether caused by detergent-oil deposits or other overheated combustion chamber surfaces, preignition can cause piston failure from melting in a few minutes, without detonation. Elimination of preignition is the aim of the new-additive oils.

Review of the annual aviation gasoline surveys conducted by the Bureau of Mines for the Coordinating Research Council—in the light of known requirements of current personal aircraft engines—discloses that physical properties other than octane number, such as volatility, gum content, and vapor pressure are well within the limits for good operation.

Up until about two years ago, none of the 80-octane aviation gasolines had the take-off, or rich, octane number controlled. It was originally thought that the worst knocking condition in an aircraft engine would be under lean cruising operation. The theory was that the extreme carburetor enrichment under take-off conditions would decrease the knocking tendency enough to more than offset any increase in octane requirement resulting from higher horsepower under take-off conditions.

Postwar flight detonation tests covering popular makes of personal aircraft proved this theory wrong. Data from some detonation tests are summarized in Table 1. The marked difference between the cruise and take-off octane requirement is apparent. These data were later verified by many subsequent flight detonation tests including tests in helicopters, special installations in crop-dusting airplanes, and twin-engine amphibians in the 450-hp and 600-hp class. In all cases, 80/87 fuel was found adequate for normal operation.

Why 80/87 fuels are needed is illustrated by Fig. 1. All curves shown are borderline-knock curves. Manifold pressures above a line result in knocking operation. Manifold pressures below the line provide nonknocking operation. With rich mixtures, higher manifold pressures may be used with any

Mr. Hanley was assistant manager of his company's Aviation Division at the time he wrote the paper from which these excerpts are taken. Eight days after he presented the paper, he disappeared in his personal plane during a flight to the northern part of California. He and the three friends with him were bound on a hunting trip. So far, neither ground nor air search parties have located the men or their airplane.

Table 1—Octane Requirement of Typical Personal Plane Engines

	Octane Requirement	RPM	Manifold Pressure, in. of Hg	Outside Air Temperature, F	Carburetor Air Temperature, F	Cylinder Head Temperature, F	Altitude, ft	Time Since Overhaul hr
Airplane A Engine Make A								
Cruise	78	2300	25.0	100	100	460	1000	13
Take-off, Full-Throttle	85	2230	29.6	100	100	525	sea level – 500	13
Airplane B Engine Make A								
Cruise	83	2180	25.0	94	100	437	3000	280
Take-off, Full-Throttle	89	2300	28.5	94	94	460	sea level – 500	280
Airplane C Engine Make B								
Cruise	74	2400	23.8	69	100	422	1000	20
Take-off, Full-Throttle	80	2300	29.0	69	69	380	sea level – 500	20
Airplane D Engine Make C								
Cruise	74	2300	23.0	86	100	400	1000	30
Take-off, Full-Throttle	88	2280	29.1	85	85	408	sea level – 500	30
Airplane C Engine Make A								
Cruise	76	2450	22	90		410	1500	160
Take-off, Full-Throttle	87	2450	29.0	90		400	sea level – 500	160

given fuel. However, paraffinic fuels (blends of octane and heptane), represented by the dotted lines and the 80-octane line, permit only a moderate increase in manifold pressure under rich conditions. They do not permit sufficient manifold pressure for take-off horsepower without knocking.

Certain other hydrocarbons, notably aromatics and naphthenes, have much less tendency to knock under rich conditions than under lean. By varying fuel composition, high rich, or take-off, octane ratings for any given lean, or cruise, octane number are obtainable.

In the example illustrated by Fig. 1, any fuel above 78 lean cruising octane number would be adequate for operation without knocking under cruising conditions. Under take-off conditions, a fuel of 87 or higher octane number would be required. (The typical 80/87 fuel shown has a cruise octane number of approximately 81 and a take-off octane number of over 88. This is common refinery practice. It has been found desirable to produce fuels which exceed the specified octane number by a small amount for control purposes.)

Use of 80-octane fuels with inadequate rich ratings in engines which require an 87-octane rich rating has caused ring feathering, high oil consump-

Table 2—Personal Plane Multicylinder Engine Oil Tests

Oil Type	LABORATORY: Eastern Nondetergent Type	LABORATORY: Heavily Compounded Detergent Preigniting Type	FLIGHT: Eastern Nondetergent Type	FLIGHT: West Coast Lightly-Compounded Detergent Nonpreigniting Type	FLIGHT: Heavily Compounded Detergent Preigniting Type	FLIGHT: Experimental Additive Nonpreigniting Type
Test Hours	100	100	618	512	507	435
Rings Stuck	4	0	3	2 Sluggish	0	0
Exhaust Valves Stuck	1	0	2	0	0	0
Ring Groove Deposit %[a]						
No. 1	100	9	73	88	19	40
No. 2	all stuck	14	100	81	24	25
No. 3	25	5	37	51	16	10
Piston Skirt Deposit %[b]	38	1	42	40	24	25
Rocker Box Deposits	light sludge	clean	very light	clean	clean	clean

[a] 100% score indicates that all of the space behind the ring was filled with deposit with the ring face flush with the piston.

[b] 100% score indicates that the piston was completely covered with black deposit.

on, and early top overhauls. But a moderate mount of detonation at take-off will not cause an ngine to disintegrate or to deteriorate rapidly.

This conclusion was reached from—among other ests—a series of 46 demonstrations given before 000 aviation personnel. A 185-hp engine installed n a personal plane was used to show the difference etween 80-octane fuels with high and low rich ratngs and the effect of continued detonation. Individual detonation pick-ups were installed on each f the six cylinders. The signal came to the meeting oom through a selector switch in the cockpit and a 250-ft extension cable, and was amplified and projected on a large projection-type television tube. An interphone between pilot and speaker and a public address system enabled the audience to follow a simulated flight test in which the airplane was tied down and operated at take-off power.

Each demonstration involved take-off-power operation for a period equivalent to two take-offs. Head temperatures reached 600 F.

After 35 demonstrations, an increase in oil consumption of 4 to 1 appeared. Dismantling the engine disclosed badly feathered rings but no other damage. The rings were replaced with new ones and the engine reassembled. Subsequent flights showed oil consumption to have returned to normal.

After 11 more demonstrations, oil consumption again rose above normal. Dismantling the engine disclosed feathered rings and slight erosion of the crown of the highest-knocking cylinder, cylinder 3.

These demonstrations and others convinced us that a moderate amount of detonation under take-off conditions, although undesirable, will not burn holes in pistons or cause other serious damage swiftly as some have claimed. Long-time operation under medium or heavy detonation will, however, cause sufficient engine damage to require earlier overhaul.

Sudden piston failures result not from detonation but from preignition.

(Detonation is abnormal combustion which proceeds initially in a normal manner, but after some part of the fuel is burned the pressure and temperature of the remaining unburned charge exceed a critical combination which the fuel cannot withstand. At this point, all of the remaining fuel burns at once—or detonates—instead of burning by the normal flame progression. This sudden burning sets up a pressure wave which, although not much higher in absolute pressure than accompanies normal combustion, has a much higher velocity than normal. This high-velocity gas impinging on aluminum parts of the engine removes particles of the metal. The removal is a mechanical process, not a thermal one.)

What Preignition Is

Preignition is combustion abnormally initiated from a hot surface other than the spark plug. If any surface in the combustion chamber exceeds 1800 F, the fuel-air mixture will ignite in much the same manner as lubricating oil ignites on a hot exhaust pipe. If this surface ignition occurs only a few degrees before normal sparking and if the oc-

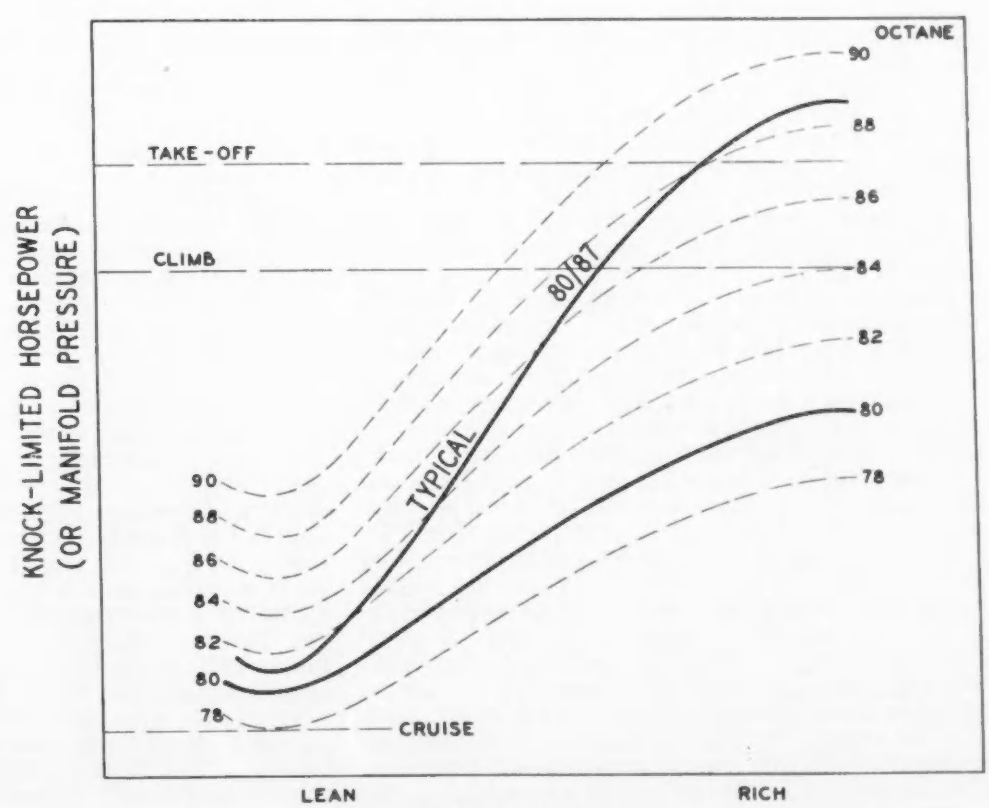


Fig. 1—Typical detonation-limited power curves

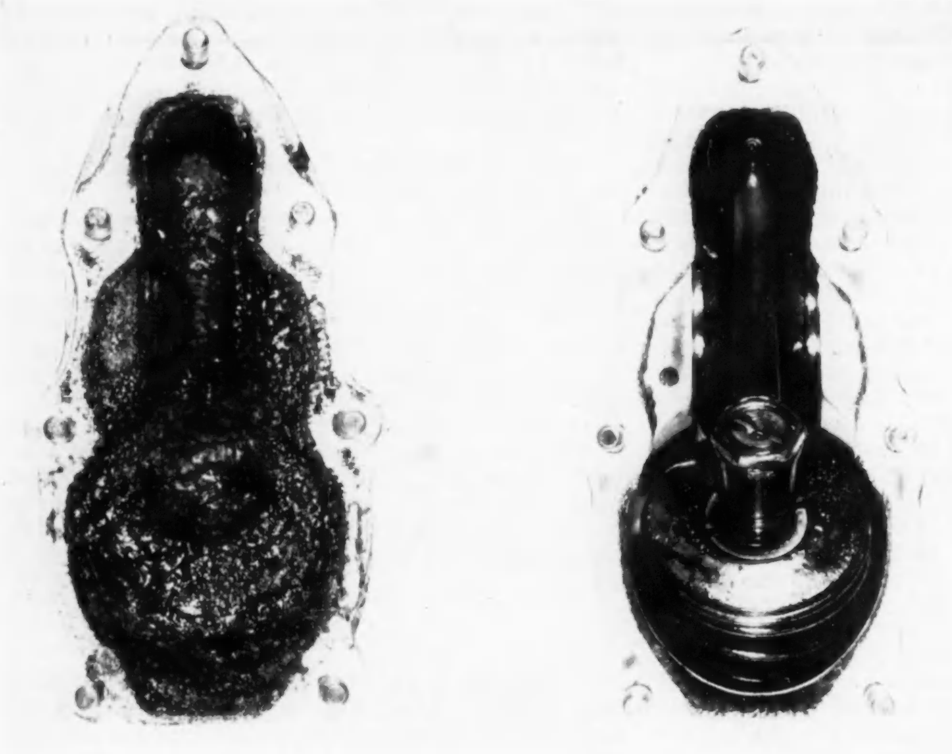


Fig. 2—Rockerbox deposits with uncompounded oil at left and new experimental nonpreigniting-type additive oil at right

tane number of the fuel is sufficiently high, detonation does not result.

However, early firing from preignition develops higher combustion chamber temperatures and pressures. These in turn cause subsequent cycles to fire still earlier. By a rapid progression, the combustion becomes very early. Extreme cases are what is generally known as "run-away preignition." If preignition proceeds far enough, the charge may be fired with the intake valve open. Either way, very early combustion can develop temperatures so high that they melt a piston in a few minutes.

A section of a preignition-failed piston will show a mottled appearance in a photomicrograph as evidence of melting.

One source of very hot combustion chamber surfaces stems from certain lubricating-oil additives. Oxides of materials used in common detergent oils have very high melting or vaporizing temperatures which prevent their elimination from the combustion chamber. As these deposits increase and become partially detached from the combustion chamber walls, they are heated by the combustion gases to a temperature above the 1800 F range required to induce preignition.

Not all detergent oils cause preignition in personal plane engines. Detergent oils may be used beneficially with certain precautions. Type and amount of detergent must be carefully controlled. It is the indiscriminate use of highly compounded automotive-type detergent oils which are satisfactory in liquid-cooled engines, rebranded for use in aircooled aircraft engines without adequate testing, that has given detergent oils a bad name in aviation service.

Actually, some type of additive is essential for maximum engine service. We know of no uncompounded aviation oil adequate to permit the greater-than-1000-hr overhaul intervals under severe operating conditions which personal plane engines can withstand from a mechanical viewpoint. Experience has indicated that because of relatively high temperatures and use of straight-sided piston rings, personal plane engines have a more severe oil requirement than medium-size airline-type engines.

Safe Additive Developed

As the result of an extensive program of aviation oil development conducted by the California Research Corporation, additive materials have been discovered which will provide cleaner engines than the highest level detergent compounds generally used, but which will not form combustion chamber deposits which can support preignition. This new class of compounds has shown great promise in the largest multicylinder airline and military engines. The compounds are now undergoing extensive flight tests in a large number of personal airplanes covering a wide range of operating conditions. Fig. 2 shows a comparison of a typical uncompounded oil and the new nonpreigniting-additive type oil when used in one of the largest airline and military engines, in which most of the testing has been done.

Table 2 shows a comparison of a typical nondetergent personal plane oil which has been widely used in the eastern part of the United States, a lightly compounded detergent oil widely used in the West, a very high level preigniting-type detergent-compounded oil, and the new nonpreigniting-additive type oil. The results in both laboratory and flight engines are shown. These tests were all made in the same type of popular personal plane engine.

Considerable care was exercised in setting up the test-stand engine in order to duplicate the most severe flight conditions. Head temperature and exhaust valve guide temperatures were measured in flight under severe climb conditions in a popular make of airplane utilizing this particular engine. These temperatures were then duplicated by proper adjustment of the cooling air on the test stand.

The 100-hr tests on the test stand under severe conditions are in good agreement with the 500-hr flight tests under normal conditions. The stuck rings and valves and high piston deposit and ring-groove deposits for the nondetergent oil in comparison with either the very highly compounded preigniting-type detergent oil or the new nonpreigniting-additive type oil are apparent. The lightly compounded detergent oil had an intermediate rating.

In addition to the depositing tendencies of oils on the piston rings and valves, the combustion chamber oil deposits are of interest—not only from a preignition standpoint but also because of their effect on detonation. Observations made during the course of flying with various types of oils indicated that the octane requirement of personal plane engines after continued use might be influenced by the type of oil used.

In order to verify this quantitatively, flight detonation tests were made on three personal plane engines of the same type. One of the airplanes selected had been flown 912 hr with the very heavily detergent-compounded oil previously mentioned. The octane requirement was measured over a range of manifold pressures. The new experimental nonpreigniting-additive type oil was then used for an additional 204 hr without cleaning the combustion chambers. At this time, the octane requirement was again measured. Immediately following this test, the combustion chamber of the worst knocking cylinder was cleaned and the octane requirement redetermined.

The results are shown in Fig. 3. Under cruising conditions, the octane requirement was reduced approximately 6.5 octane numbers by subsequent operation with the new-type nondeposit-forming additive oil. Cleaning the combustion chamber reduced the octane requirement an additional 4 octane numbers in that cylinder.

In another engine which had been operated 334 hr with the very heavily compounded detergent oil only, cleaning the combustion chamber reduced the octane requirement approximately 6 octane numbers.

In another engine operated 200 hr with the new experimental nondeposit-forming oil only, there was no change in octane requirement during this operating period.

The flight-test engines observed to date on the new nonpreigniting-type additive oil have shown remarkable cleanliness. When these tests are completed to the full overhaul period beyond 1000 hours in the 32 light planes on test, a more conclusive demonstration of the merits of this type of compounded oil will be available. Although we know from the composition of this new additive that it is physically incapable of forming deposits which can induce preignition, very extensive preignition tests have been run under all conceivable conditions. The lack of preignition predicted has been verified.

This new type of aviation oil is expected to establish a new era in personal plane engine operation, with overhaul periods well in excess of 1000 hr and no possibility of preignition from combustion chamber deposits.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members, 50¢ to nonmembers.)

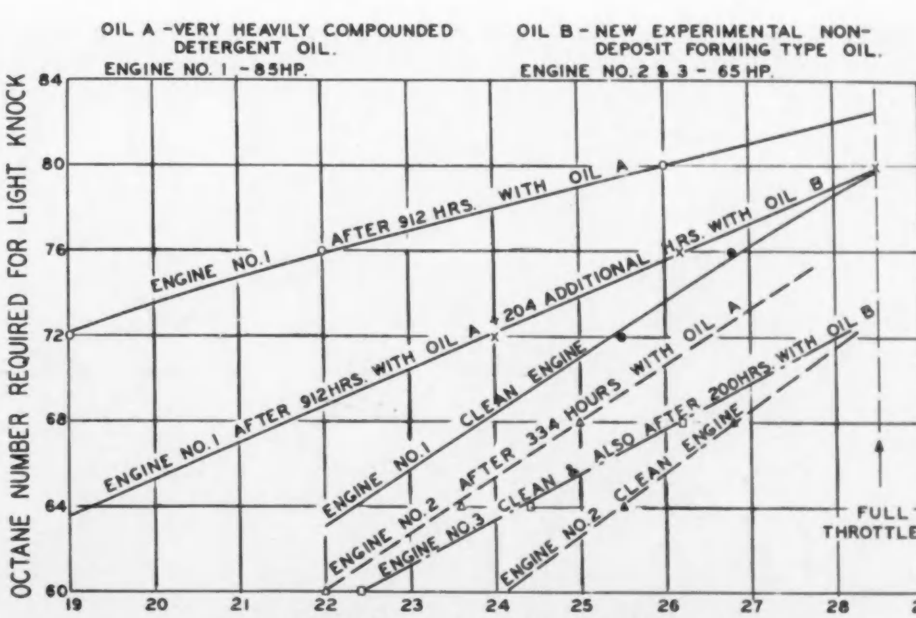


Fig. 3—Effect of lubricating oil type on octane requirement of personal plane engines

Engineers Seek Light

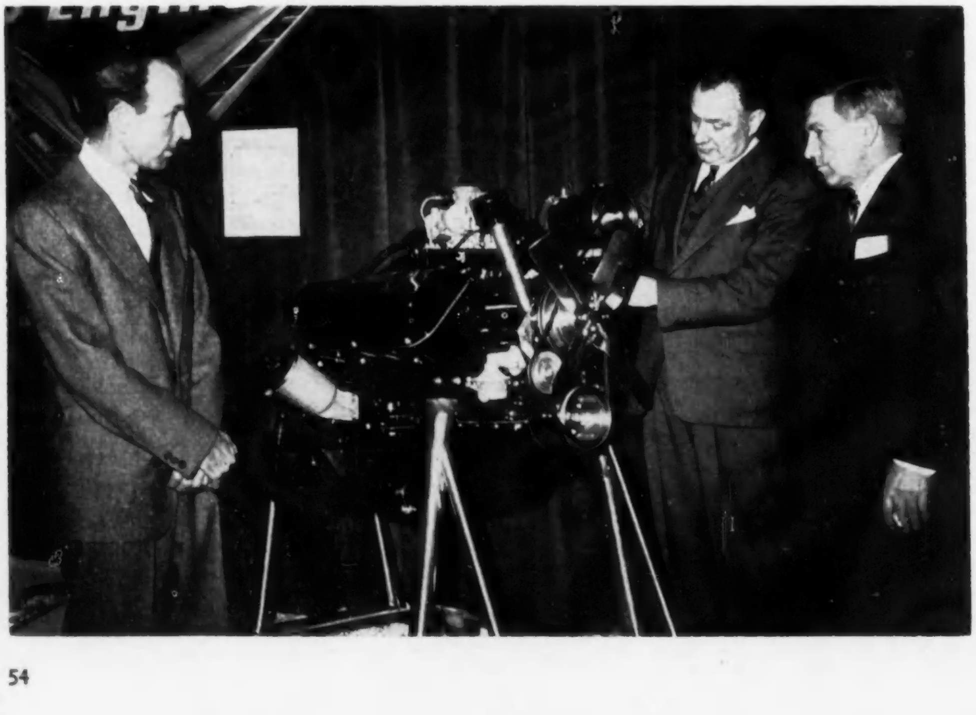
THE mood of the nation—let's beat our plowshares back into swords while retaining as many plowshares as possible—was well reflected in the engineering talk of the fifth SAE National Passenger-Car, Body, and Materials Meeting held in Detroit, March 6-8. This mood manifested itself in extensive discussions of strategic materials, where the thought was expressed that if we want both "plowshares" and "swords," we've got to do a lot of studying and planning to make the best use of what we have.

Undoubtedly the most important single contribution along these lines discussed at the meeting was the use of boron in steels. Boron is doubly important, first, because, when added to steel in small amounts it can replace much larger quantities of alloying elements now in critically short supply, and second, because we have all we need of it.

That we are still thinking of our "plowshares" was also evident, for many nonmilitary papers were presented. These showed that engineers have not been checked from giving thought to how to make motor vehicles better, safer, and be more comfortable. And there was every evidence to show that they intend to continue with this effort.

Strategic Materials

"I don't know what weapons we'll use in the next war, but the one after that will be fought with sticks and stones." That was how one engineer at the meeting tried to emphasize the importance of sound planning in the use of strategic metals. If we don't, he said, we'll surely soon find ourselves without the proper weapons to fight a modern war. This idea was echoed by others, who suggested that, just because we had the alloys in the last war is no guar-



W. E. Drinkard (left) and M. L. Carpentier (center), Chrysler Corp., show H. E. Churchill, session chairman, some of the features of the new Chrysler V-8 engine, which was displayed at the meeting

on Strategic Materials

Engineers Discuss Conservation Of Materials in Critical Supply

antee that we will have them in the future.

Our general planning, as one expert put it, is going to have to include the idea of doing without alloys steels, especially the high-alloy types, whereever possible. We should use lower alloy steels, he said, even if we have to design things heavier. He suggested—reluctantly—that we may even be forced to give up some of our much-prized equipment durability. For example, he said, let's face it, a jet engine in combat just doesn't last 200 hr, so why require it to pass such extensive life tests. Finally, he advised his listeners to learn everything possible about boron-treated steels—their bad points, as well as their good ones.

As an aid to deciding just where we stand, several speakers presented specific data on the availability of many of the strategic materials.

For example, one steel representative went on record by saying that we have iron ore available for the production of 100,000,000 net tons of steel ingots per year. Whether or not we could produce all this steel depends, he assured his audience, on how well we solve a number of problems. A very disturbing factor for 1951 production is, he said, the problem of obtaining sufficient scrap. The changeover from peacetime production to war work means shutdown periods when little scrap is made. Also, war production is involved in very long cycles of time, so that it takes much longer for scrap to appear, once the changeover has been made.

Then there are the unknowns of adequate transportation, power, and labor. The real pinch will come in the alloying elements, and here the unknowns of stockpiling and undefined needs make prediction hazardous. Only molybdenum, vanadium, and titanium can be had in sufficient amounts to justify optimism. This is not true of maganese, chromium, cobalt, columbium, nickel, and tungsten, all of which will be in short supply as far as the steel industry is concerned.

Engineers were warned not to be fooled by figures of industrial capacity as the measure of what can be produced. The bottleneck, it was said, might easily be manpower rather than materials. War production demands more man-hours per unit of raw material. Whereas automobile producers deliver 3 lb of car for 1 hr of wages paid, a World War II tank represented 1 lb per hr of wage, and that figure will probably be cut in half for World War III. During the last war the Germans had steel stocks unused at all times even though they used slave labor in every possible operation. Their conditions on manpower requirements went far astray and ours could, too.

The situation in the nonferrous field is no rosier than that in the ferrous field, engineers were told. All such materials are in very tight supply. As one speaker put it, superimposing a heavy armament program on top of a record civilian production is reason enough for tight supply; but when you add to this the scramble for materials to build up inventories for exports, speculation, and hoarding, and, finally, for Government stockpiling, you have a fantastic demand that world supplies simply cannot approach.

Aluminum has the most favorable longterm outlook of any nonferrous metal, the experts said. It is in tight position today, but supplies will be increased. To expand copper supplies, new mines must be opened and that takes time. Furthermore, the output of new mines is problematical. Lead consumption is at record levels with demand unmet, and the chances of major world increases are slim. Zinc will be scarce for some time, but the recent moratorium on stockpiling plus the cilivian use cutback should result in a reasonably well balanced supply in the near future. Magnesium, too, is scarce, but with the reactivation of Government plants, the total volume will grow, although costs will go up, too.

If those attending the meeting hoped to come away with their apprehensions over the material supply situation banished, they were disappointed. No matter how the speakers and discussers juggled figures of supplies on hand, or available in the earth somewhere around the world, the threat of real shortages and the need for strict conservation remained.

For this reason, if for no other, more than usual interest was aroused by the possibility of using boron steels as substitutes for steels alloyed with

SAE Activity Vice-Presidents and General Chairman

Left to right: F. P. Zimmerli, vice-president for Engineering Materials Activity; E. H. Kelley, chairman, General Committee; G. A. Delaney, vice-president for Passenger-Car Activity; and F. A. Hall, vice-president for Body Activity

scarce elements. The forecast was made by one speaker that within one year there would be widespread production of boron steels for civilian as well as military applications. This suggested that boron steels might become to this rearmament era what the NE steels were to World War II.

Specifically, what the boron does is to increase the hardenability of the steel—its ability to harden deeply when heated and quenched. This ability is not unique for boron—it is what most alloying elements do when added to steel. The unique part is that only very small amounts of boron are needed. For example, 0.001% boron will give the same hardenability as 0.3% manganese, or 0.35% molybdenum, or 0.5% of chromium, that is, it is equivalent to 300 or 400 times the weight of other alloying elements. The effect decreases as carbon content is increased until it is nil at 1%.

Steels alloyed with boron have already been used successfully in a number of applications, engineers were told. Ordnance made use of them toward the close of World War II, while industry has employed them since for induction-hardened diesel crankshafts, cold-headed bolts, large tractor axle shafts and pinions, and hand tools.

Boron steel, it was added, also has the advantage of annealing with shorter cycles, is less damaging to hot-working and cold-heading dies, and has improved machineability. Unfortunately, it has a few limitations, but none that are serious. The grain coarsening temperature has been found to be slightly lower than for other steels, but this should cause no trouble unless the heat-treat temperature is allowed to run abnormally high or very long. Charpy notched-specimen impact strengths are slightly lower at low hardnesses, but again it is not enough to be serious unless severe shock is anticipated at very low temperatures. In this case more alloy might be needed to overcome the limitation.

The use of substitutes to keep production going at high levels will continue as a problem whether the goods are made for civilian or military use. This was made very clear by one speaker's presentation of military needs and the conservation measures being practised by Ordnance. Even here, engineers were told, steps have been taken, and more will be taken, to substitute for scarce materials wherever possible.

Research at the Watertown Arsenal, for instance, has resulted in the development of ferritic electrodes suitable for welding armor and high-strength constructional steels, thus conserving chromium and nickel. Ordnance is also investigating the use of porcelain-coated mild steel to replace stainless steel in manifolds and mufflers of combat vehicle engines.

It is the policy of Ordnance to give serious consideration to use of new materials of all types, engineers were told. Magnesium, for example, hitherto rarely specified in Ordnance design, may come into wider use. Promising research has been conducted to develop a surface treatment which will provide protection against corrosion with excellent resistance to abrasion and ability to withstand heat.

Titanium is also under scrutiny. It is conceivable, said this speaker, that titanium alloys can be substituted, thickness for thickness, for steel armor, thus reducing weight by 40%. Much work has been done with plastics and organic coatings, and both of these will be used to conserve critical materials.

Ordnance men also let it be known that manufacturers of cargo bodies for military wheeled

vehicles must be capable of switching from steel to wood construction for floors. Vinyl-covered fabric is already being specified for seat covers to release scarce canvas duck for cab tops and body tarpaulins.

Of special interest to engineers who may become engaged in building military vehicles was the report that Ordnance was making an effort to keep the various types of vehicles at a minimum. While this does not necessarily reduce consumption of strategic materials, it should result in a saving in manpower and thus make a contrubution to the solution of the overall problem.

Present policy, engineers heard, is to have basic chassis within each weight class. These basic chassis will incorporate features permitting use of a maximum number of body types. This policy, it was said, would apply to trailers and semitrailers as well as to trucks.

Chrysler V-8 Engine

Discussion of ways and means to improve the performance of passenger cars, a more cheerful topic than strategic materials, was highlighted by a presentation of the design features of the new 331 cu in., 700-lb, Chrysler V-8 engine, and the engineering thinking behind its development.

A conviction that the combustion chamber is the heart of an automotive engine, said the speaker, led to extensive studies of all types. Throughout this research one chamber—the hemispherical—displayed excellent volumetric and indicated thermal efficiencies, and the ability to maintain them in service.

The higher basic thermal efficiency is of particular importance, he said, because it must result in more efficient overall utilization of fuel—and there are also distinct gains in other essential performance characteristics.

It was granted, he said, that the compression ratio is an important factor influencing the indicated thermal efficiency of an engine—but it is not the only factor, publicity notwithstanding. Differences exist between combustion-chamber designs that have greater influence on thermal efficiency than do marked changes in compression ratio.

Thermal and volumetric efficiencies are adversely influenced by combustion-chamber deposits. Many engines, it was declared, suffer a full-throttle power loss as great as 10% after only 5000 to 10,000 miles of operation. This loss is equivalent to one resulting from a compression ratio reduction of one full unit, and the accompanying use of gasoline of about 10 octane numbers lower.

About one-third of this loss is due to reduction in indicated thermal efficiency, about two-thirds to lowered volumetric efficiency. In the hemispherical combustion chamber both these losses are sharply reduced. There is a minimum of detonation increase and preignition tendency with the accumulation of combustion-chamber deposits.

Another advantage claimed by the speaker was a very low heat rejection to the coolant. Potentially, this means a smaller, lighter, and less expensive coolant system for an engine of the same power.

In designing the cylinder block for this engine the objectives sought were: low weight and bulk, better operating smoothness and quietness, increased durability, and lower friction. This led to the use of a 90-deg V-8 engine.

Although it has a high compression ratio (7.5 to 1), this engine need not be operated with premium-grade gasoline. Three explanations for this were offered by the speaker. They were: absence of preignition, relatively low increase in octane-number requirements due to combustion-chamber deposits, and an increase in the apparent octane-number rating of the majority of commercial gasolines.

Instrumentation

One aspect of the problem of improving the performance of motor vehicles is to have suitable procedures, measuring devices, and test equipment for the study of components. Toward this objective much work is being done, it was revealed to those attending the meeting. Engineers reported progress made in developing dynamometer equipment, instruments for observing and determining valve

Under the general chairmanship of **E. H. Kelley**, the following served as chairmen of the eight technical sessions of the SAE National Passenger Car, Body, and Materials Meeting: **H. E. Churchill, W. P. Eddy, R. A. Terry, E. J. Hergenroether, V. M. Exner, W. E. Lyon, J. B. Macauley, Jr., and A. T. Colwell.**

This report is based on discussions and 18 papers . . . "Development Highlights and Unique Features of the New Chrysler V-8 Engine" by **W. E. Drinkard** and **M. L. Carpentier**, Chrysler Corp. . . . "Status of Ferrous Strategic Materials—Government and Industry Situation and Rulings" by **E. C. Smith**, Republic Steel Corp. . . . "Non-Ferrous Strategic Materials—Government and Industry Situation and Rulings" by **R. J. Lund**, Battelle Memorial Institute . . . "Military Tactical Wheeled Vehicle Body Requirements" by **Capt. J. L. Quinnelly**, Ordnance Dept., Detroit Arsenal . . . "Boron Treated Steels" by **Porter R. Wray**, United States Steel Corp. . . . "Materials of Military Motorized Equipment" by **Col. B. S. Mesick**, Chief of Research and Materials Branch, Ordnance Dept. . . . "Engineering Safety Into Automobile Bodies" by **H. K. Gandelot**, General Motors Corp. . . . Tire Symposium: "Tire Noises" by **W. F. Perkins** and **W. F. Billingsley**, B. F. Goodrich Co. . . . "Safety and Ease of Car Handling" by **J. J. Robson**, Firestone Tire and Rubber Co. . . . "Riding Comfort" by **R. D. Evans**, Goodyear Tire and Rubber Co. . . . "Tire Wear and Durability" by **A. W. Bull**, United States Rubber Co. . . . Instrumentation Symposium: "Development of a Modern Dynamometer Laboratory" by **C. L. Bouchard** and **Herbert Oxley**, Ford Motor Co. . . . "Some Developments in Dynamometer Equipment" **W. H. Smith** and **J. B. Bidwell**, Research Laboratories Division, GMC . . . "A Study of Vehicle, Roadway, and Traffic Relationships by Means of Statistical Instruments" by **T. J. Carmichael**, GM Proving Ground, and **C. E. Haley**, Committee on Vehicle Characteristics, Highway Research Board . . . "The Lashograph—An Instrument for Observing Valve Lash of a Running Engine" by **E. B. Etchells**, Chevrolet Motor Division, GMC . .. "Strain-Gage Method of Determining the Running Lash of L-Head and Overhead Engines" by **A. E. Cleveland**, Ford Motor Co. . . . Symposium—Improved Performance through Sound Valve Gear Design: "Camshaft Design as Related to Valve Train Dynamics" by **T. R. Thoren**, **H. H. Engemann**, and **D. A. Stoddard**, Thompson Products, Inc. . . . "Valve Lash, Automatic Tappets and Instrumentation" by **Vincent Ayres**, Eaton Mfg. Co. . . . **All of these papers will appear in abridged or digest form in forthcoming issues of SAE Journal, and those approved by Readers Committees will be printed in full in SAE Quarterly Transactions.**

lash in different types of engines, and a new method for computing cam contours.

Commercially available dynamometers and scale equipment are well suited for most engine testing, said one speaker but, to get the desired degree of accuracy for studying the special problem of engine friction, refinement of equipment was necessary. Here it is essential, it was pointed out, to be able to measure accurately small changes in engine output, since individual modifications to the engine may produce only small gains or losses. When we are able to determine accurately which modifications improve efficiency, then it may be possible to combine several changes to give a cumulative substantial gain.

Engineers were also given a very complete picture of Ford's new dynamometer laboratory where particular emphasis has been laid on good maintenance conditions, good working conditions for test operators and precautions for their safety—to mention only a few factors.

Two methods were presented for studying valve lash—the clearance between value stems and rocker arms in valve-in-head engines. One method employs strain gages while the other makes use of a mechanical-optical device. The practical value of the strain-gage lashometer, engineers were told, lies in the grouping of observed data so that study can be made of control variables.

Studies made to determine the effect of deposit accumulation in 10,000 miles of service revealed that valve lash is approximately 20% greater without deposits than with them. This is due, the speaker explained, to the heat insulating effect of the deposits at the exhaust valve head, making it easier for a clean, new valve to absorb heat from the gases than for the deposit-insulated older valve to do so. It was also pointed out that, after 25,000 miles of service, the effect of engine wear and deposits was one of narrowing the variation between valves in a new engine. This indicates, he said, that much of the valve-lash variation in new engines is caused by differences in production fits of wear parts and heat flow paths, later neutralized by corrosive and electrolytic action.

Exhaust valve guide design, clearance between exhaust valve guide and block, exhaust valve guide to stem clearance, and length of valve guide, all effect valve lash, it was disclosed.

Other tests showed that coolant temperature variations can produce substantial changes in valve lash. For example, under full-load conditions a decrease in coolant temperature from 180 F to 100 F can result in a change in exhaust valve lash of as much as 0.006 in.

Emphasis then shifted from the problem of valve lash per se to that of proper cam design. A method was presented whereby cam contour can be computed to produce a definite predictable valve motion in high-speed engines. The procedure, as outlined for the benefit of those attending the meeting, was to write a polynomial equation to describe the desired valve motion between zero lift and the maximum lift. The next step was to compute the equivalent cam lift curve by means of a second equation, which includes the factors of ramp height, valve train static deflection, and dynamic deflections, which are caused by the reciprocating masses.

The advantage of this method, the speaker claimed, is that cams so designed produce actual valve motion at design speed which is very close to desired valve motion as expressed by the polynomial equation.

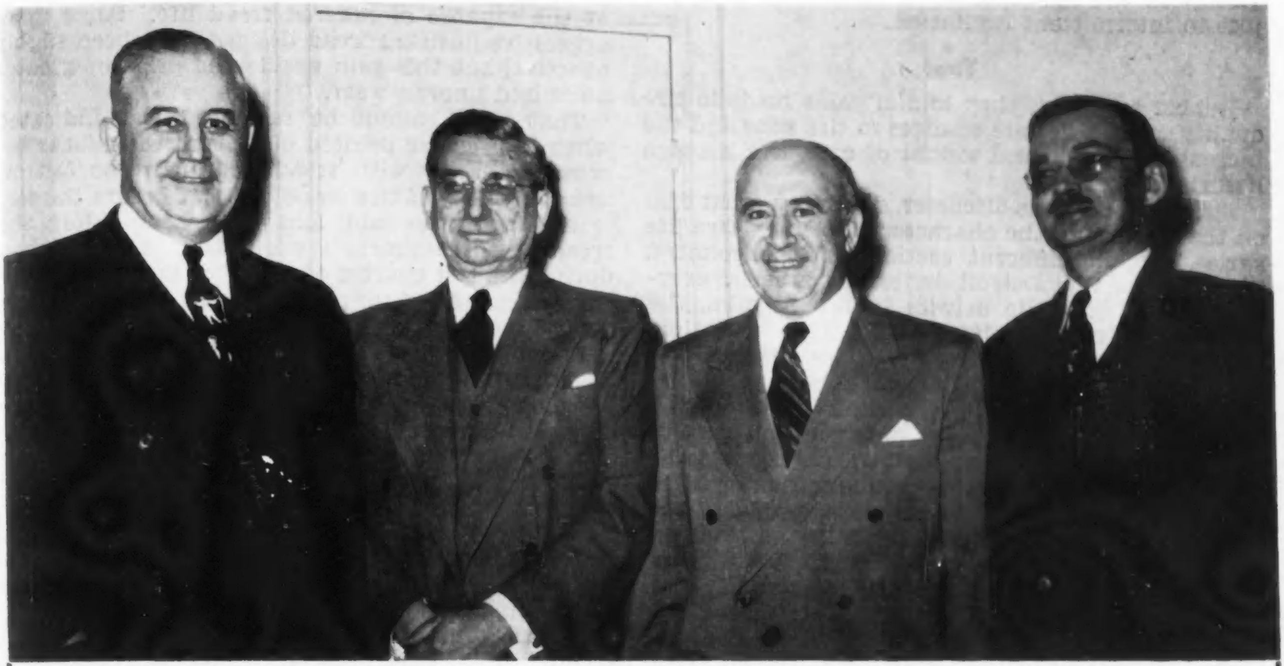
The experimental results given by the authors disclosed, it was pointed out, that correlation between the design motion and the actual dynamic motion is not yet ideal. At the design speed the valve closing velocity should be zero. The existence of some valve bounce at and below the design speed indicates, the discusser said, that the dynamic valve motion is not exactly what has been designed into the cam.

In addition to small differences in valve train flexibility from valve to valve and to nonlinear elasticity of the linkage, this discusser indicated that there are other causes that it might be wise to consider, with the objective of arriving at additional criteria for controlling the valve motion.

For instance, he said, gas loading variations can be shown to have significant influence on the prob-

Among those present at the Speakers' Table were (left to right): Brig.-Gen. Phillips W. Smith, chief, Procurement, Air Materiel Command, Wright Field; Brig.-Gen. Wayne Allen, assistant chief, Procurement Division, Department of Army; and Rear-Adm. Paul E. Pihl, USN, Bureau of Aeronautics, General Representative, Central District, Wright Field

Speakers at the Dinner



Left to right: Harvey Campbell, toastmaster; Harry J. Klingler, chief dinner speaker; Dale Roeder, SAE President; and L. I. Woolson, chairman, SAE Detroit Section

A PREDICTION that by 1960 this country will have 48 to 50 million passenger cars on the road was made by Harry J. Klingler, vice-president of General Motors Corp., who was chief speaker at the dinner held in connection with the SAE National Passenger Car, Body, and Materials Meeting.

L. I. Woolson, chairman, SAE Detroit Section, opened the program with a brief speech of welcome in which he pointed out that this was the fifth time the "passenger car" meeting had been held in Detroit, the first one being in 1938. He then turned the program over to Harvey Campbell, executive vice-president of the Detroit Chamber of Commerce, who acted as toastmaster.

1951 SAE President Dale Roeder suggested that the automotive industry had one very potent secret weapon in the give and take of the swapping of engineering information—an important factor that totalitarian nations just don't understand. We know, he said, that their workers in many fields have to operate by decree, and it would be surprising if science alone could escape such regimentation.

This meeting, he continued, is a fine example of how we are able to get together to exchange information. The members of the SAE, he concluded, must not miss the opportunity to show what they can do in our present state of partial war to help us build up our armaments.

In his address "Engineering and Management," Harry Klingler discussed the importance of engineers getting at least a speaking acquaintance with the other parts of the automotive business.

The engineer, he said, is a valuable man in any business setup. The new problems that develop with each working day keep his mind nimble and young.

He suggested that the engineer be present when important managerial decisions are being made, participate in advertising conferences, and go on sales trips.

Actually, he pointed out, merchandising must go hand in hand with engineering. He cited the acceptance of the automatic transmission by the public as an example of what constant merchandising, coupled with many engineering improvements, can do.

The modern automobile, he reminded his audience, is one of man's most marvelous creations. It provides employment for one out of seven. It pays a good share of our taxes. It has changed our entire way of life. Thanks to the automobile, suburban areas have been able to grow at a much higher rate than urban ones, for other forms of transportation have not been able to keep pace with this expansion.

ability of a valve jump developing on the opening side, so that conditions would no longer be those assumed in the design. Also, transient linkage vibrations are inevitable in a flexible system subject to intermittent excitation.

Tires

Rubber engineers then told of gains made in tire quality so that, despite changes in tire sizes and the increase in power and weight of cars, tire mileage had risen steadily.

Tire wear, said one discusser, depends a great deal on the driver and the character of roads. Tire life varies, too, in different sections of the country. Studies show that Detroit drivers get a better average mileage than do drivers in Los Angeles, the ratio being roughly 100 to 62. This variation, which persists year after year, is due primarily to climatic and geographic differences.

When the engineers got around to discussing riding comfort, it was the tire men who had most to contribute. Said one of them, if the only consideration in the design of a tire was elimination of noise we could make an almost noiseless product, but when satisfactory traction, stability, cornering power, and tread wear are also sought, there must be some compromise. A tire with high stability and low traction is desirable from the standpoint of ultimate service and low noise, but undesirable from the standpoint of ride and antiskid.

It was pointed out that a considerable business exists in treating tire treads to increase their antiskid properties at some expense of noise. One engineer thought that if this represented public desire less emphasis should be put on noise suppression and more placed on improving antiskid performance. Most tests for original equipment tires are based on dry road performance, whereas a high percentage of car driving is done on wet roads. If this fact were recognized, it was thought, a realignment of tire characteristics might well favor the acceptance of a better antiskid tire at the sacrifice of some increase in noise.

Granting that the modern tire must be a compromise of desirable qualities, one tire technician suggested that it would be a good idea to probe the generality, "the lower the pressure, the better the cushioning, and the softer and less harsh the ride," even though it had become almost axiomatic. He then showed those present how it could be done, using what he called the axle-rise technique. This laboratory method, he claimed, correlates fairly well with road tests, the lack of exactitude probably being due to the fact that in the lab tests, the tires are distorted at a very low speed rather than at road speed.

There was agreement among tire men that no startling changes in tires were in prospect and that what changes were made would come slowly and only after long experimentation.

Tire, body, and highway traffic engineers, all had something to contribute to the subject of motor vehicle safety. Tire men made it clearly evident that there is a very close tie between noise and safety when they pointed out that good antiskid properties meant more noise. It was quite possible, it was said, that present noise level standards of tires will be exceeded in the future if the continued demands for safer vehicle operation are to be met.

Attempts to increase tire traction have not been very successful, it was noted. Embedding foreign particles in the tread can improve traction, but only at the expense of lowered tread life. Some more aggressive antiskid tread designs have been highly effective, but this gain exacts the price of greater noise and uneven wear.

That wear cannot be sacrificed was indicated when a discusser pointed out that tire failures increased sharply with tread wear. In the Detroit area only 11% of tire troubles occur before the tire is half worn, he said, and 40% occur before the tread is three-quarters worn, thus, 60% happen during the last quarter of tread mileage.

Engineers lined up in two camps as regards the safety factor in certain features of the modern automobile. A body engineer claimed that lowering bodies, moving rear seats forward, and lowering the passenger load weight had contributed to the lowering of the center of gravity and had improved weight distribution, thus giving better cornering and road stability, which adds up to more safety.

Tire engineers thought differently. They held that putting more load on the front than the rear axle had reduced traction and they reported their customers complaining of wheel slippage and spin. This increased tendency to spin had been aggravated, they maintained, by horsepower increases which had an effect similar to moving the center of gravity forward.

It was admitted by a body engineer that some criticism had been leveled at designers for the excessive overhang found in some designs, but the overhang with all its grillework contributed to passenger safety, he declared, because it gave more shock absorbing protection in the event of collision.

Body stylists then told of the efforts being made to improve safety in small ways as well as big ones. The hazard of cuts and scratches, it was said, has been reduced by paying attention to such details as sharp corners on doors and deck lids, sharp sheared bottom edges of instrument panels and front seat frames. A similar attention to small details is being given to military wheeled vehicles, engineers were told. The interiors of their cabs must now be free of sharp corners, edges, or projections which might cause injury to operating personnel.

Highway traffic engineers then presented to those attending the meeting some studies which had profound safety implications, but the purpose of the presentation was to show how instrumentation could be used to establish an engineering basis for rating roads when funds were to be allocated for construction and maintenance. The instruments were used to measure differences due to: the roadway itself, drivers, changes in urban streets, that is, one-way and two-way, traffic volume, and signal systems.

These tests showed among other things, said the engineers, that drivers spent much more time in the illegal speed range when the simultaneous signal system was used than when the progressive system of lights was employed. Furthermore, travel time and fuel consumption were higher. In the case of this one avenue studied, engineers figured a saving of nearly $250,000 a year in fuel cost would accrue to motorists with a switch to the progressive system.

Low-Tension Ignition System

BASED ON PAPER* BY

W. Beye Smits and P. F. H. Maclaine Pont,

Smitsvonk N. V. Research Laboratory

* Paper, "Smitsvonk Low-Tension Capacity Ignition System," was presented at the SAE Annual Meeting, Detroit, Jan. 10, 1951.

A NEW type of ignition system has been developed that uses a relatively low voltage throughout. It has many advantages for engines used in both ground vehicles and aircraft.

For example, as compared with the conventional high-tension ignition system, this development offers the following:

1. The system uses a universal spark plug suitable for every kind of internal-combustion engine.

2. The spark plugs are constructed so that the surface presented to the inside of the combustion chamber is practically flat and unbroken. Thus, there are no cavities to become filled with very hot combustion gases and tend to cause preignition.

3. Increased engine performance and smoothness, especially at low speeds, because of (1) a higher energy release per ignition spark (and consequently better flame travel) and (2) very accurate timing, even at high engine speeds.

4. The system can operate efficiently up to very high engine speeds, even 40,000 rpm, without becoming unduly complicated.

5. Atmospheric conditions or the condition of the dielectrical medium have practically no influence on the accuracy of timing.

6. Entire spark plug may be submerged in water without any appreciable effect on the spark between the electrodes.

7. Utter insensitivity as to fuel to be ignited. The efficiency of sparking is not affected by the use of diesel fuels, fuels with high concentrations of tel, or fuels depositing a lot of impurities or soot. Even bituminous fuels, such as tar, can be ignited, provided suitable condenser capacities are chosen.

8. Fouling the spark plugs improves engine performance.

9. Fouling the plugs as the result of a glazing of lead compounds and other contents of the fuel does not occur.

10. Ability to ignite leaner mixtures than conventional system.

11. Ability to operate satisfactorily at great altitudes.

12. For jet engines a special construction has been developed that makes it possible to light the burner even at very high combustion air speeds (2.5 lb per sec) and also at very low fuel pressures (8 psi) without explosive effects to damage the turbine parts.

Description of System

The new system makes deliberate use of the tendency toward electrical leakage along the surface of an insulator.

As can be seen from Fig. 1, a condenser is used

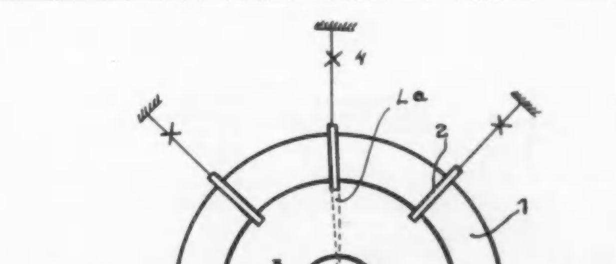


Fig. 1—Diagram showing low-tension ignition system
(1) Distributor housing, (2) fixed contacts, (3) rotating contact arm, (4) spark plugs, (5) ignition condenser, (6) adjustable resistance, (7) sliding contact, (8) supply condenser, (∠a) arc through which active surfaces of contact arm and fixed contacts facing each other extend

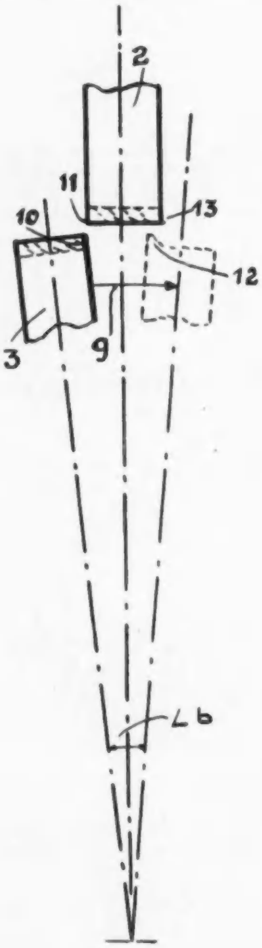


Fig. 2—Detail showing contacts
(2) Fixed contact, (3) rotating contact arm, (9) arrow indicating direction of rotation, (10-11) edges of contacts where spark begins to jump when contacts are new, (12-13) edges of contacts where spark will jump after contacts have worn, (∠b) angle of wear, which determines variation of timing
Compensation for relatively heavy wear of these contacts is made by giving contacts facing each other greater axial length, and thus a long path of wear without upsetting accuracy of timing

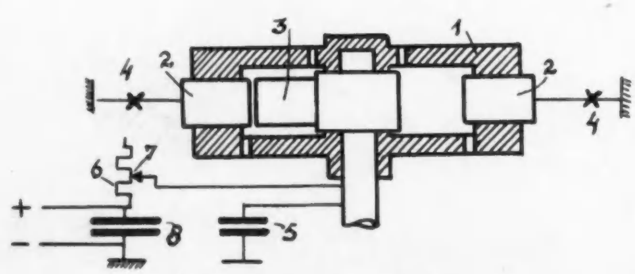


Fig. 3—Cross-section of distributor
(1) Distributor housing, (2) fixed contacts, (3) rotating contact arm, (4) spark plugs, (5) ignition condenser, (6) adjustable resistance, (7) sliding contact, (8) supply condenser
Contacts (2) and (3) are axially relatively long, giving long path of wear without upsetting accuracy of timing

as the source of electrical energy supply, so as to attain a basically fixed amount of energy for every discharge.

With low-tension capacity ignition, as with high-tension ignition, the sources of supply can be magnetos, coils, or sources of direct current. Low-tension magnetos can be made cheaper and of a simpler construction.

The timing mechanism (contact breaker) is no longer necessary, for its function is taken over by the low-tension distributor. This is a great advantage as the breaker mechanism is a source of constant trouble, especially in complicated magnetos such as used for aircraft.

Because of the much lower voltage, insulation requirements are different and such magnetos are dependable up to very great altitudes without special precautions being necessary (no pressurizing). When coils are used as the source of supply, they can also be made cheaper, as the voltage in the secondary circuit need not be higher than about 2000 v. By suitable means the efficiency of the coil can also be improved, so that 40% is easily achieved.

For very high-speed engines, the ignition of the normal system becomes inoperative, because the time to build up a flux becomes too short. With the low-tension system a very easy solution becomes available: use two condensers, one being the storage condenser, which is connected to a constant supply system and from which the second or ignition condenser is fed. As the time to charge, and to discharge, a condenser is extremely short, such a system can operate efficiently up to very high engine speeds.

Because of the disadvantages of the conventional timing method, a new system of timing was developed whereby the determination of the ignition spark is controlled solely by a suitably made distributor. Herein the supply contact of the rotating arm is connected to the (charged) condenser and this rotating arm touches the fixed contacts in the distributor housing, which are connected directly to individual spark plugs. Again because of the low tension the current will pass only when direct contact is made between the rotating arm and the fixed contacts, so that atmospheric conditions or the conditions of the dielectrical medium thus have practically no influence on the accuracy of timing.

A very accurate timing is achieved by making the contact surfaces of the rotating arm and the fixed contacts very small, that is, the surfaces of the rotating arm and the fixed contacts facing each other extend with respect to the axis of revolution of the rotating arm through an arc of less than 10 deg. (See Figs. 2 and 3.)

The dimensions of such distributors can be very small, even for multicylinder engines, because of the reduced tendency of the spark to jump gaps.

To make best use of the direct condenser discharge, the construction of the spark plugs was concentrated on the flush gap or surface discharge design, which has a supported gap. (See Fig. 4.) With such a design a semiconductive spark path can be incorporated between the electrodes. The distance between the electrodes was made very small (of the order of 0.012 in.) so that the lowest possible voltage could be used, at the same time increasing the amperes component of the spark. Because of the low voltage new methods of construction could be used so this plug was given excellent heat conductivity.

Different heat values are no longer necessary. The cooler the plug can be kept the more chance there is to accumulate deposits on the sparking surface, necessary to keep the resistance of the semiconductive separating member between the electrodes very low. A decrease in electrode wear is an additional advantage. Accumulated deposits on the

spark-plug surface will, moreover, increase the energy of the sparks at the point where these occur.

On account of the very high energy released with every discharge, electrode wear is considerably higher than for the normal high-tension spark plug. The electrodes are, therefore, designed as concentric rings so as to give a long path of wear. The spark will wander along the entire length of the circular path, always choosing its crossing point at such places where the resistance is least. When the electrodes are worn at a particular point, the resistance increases with the gap width and the spark automatically occurs at another point, so that eventually the whole circle is worn down and the plug becomes inoperative.

The sparking element is made as a separate unit, which can be easily fitted in different sizes of plug bodies, as necessary for present-day engine constructions. The dimensions of the sparking element are, however, standardized for all types of plugs, and it is not necessary to change it for any change in engine type, design, or service.

Test Results

The following tests were carried out:

1. To establish the ability to cope with high lead concentrations in the fuel, one of the experimental plugs was run in a CFR engine for 55 hr (see Fig. 5) under the following conditions:

Speed, rpm	1800
Imep, psi	113
Compression Ratio	5.5/1
Mixture Strength	1.1 (10% rich)
Intake Temperature, F	158
Spark Advance, deg	25

Fuel: 100/130 aviation gasoline with addition of ethyl fluid to give 11 cc tel per imperial gal.

The engine was stopped about every hour for a check of the electrical resistance of the spark plug. It was not possible to detect any correlation between electrical resistance and sparking voltage, since the resistance varied very erratically between 2500 and 5,000,000 ohms. This phenomenon may be explained by an alternate formation and exploding of deposits

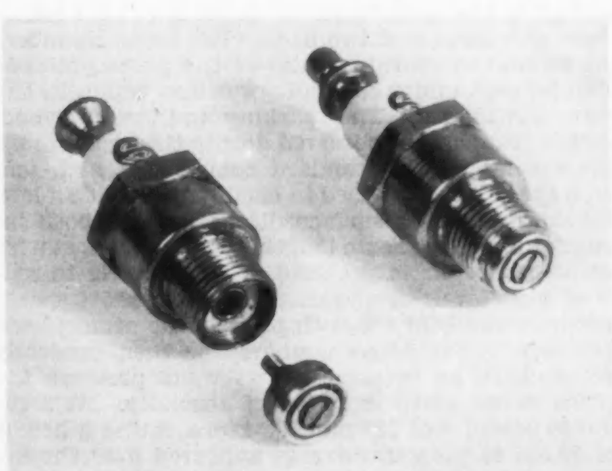


Fig. 4—Low-tension capacity spark plugs—(left) with sparking element detached, (right) with sparking element assembled

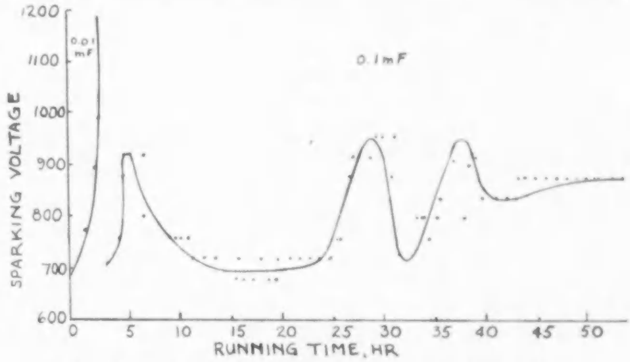


Fig. 5—Sparking voltage during test run on leaded gasoline

in the spark gap, so that with each spark the resistance might change its value.

2. To establish the ability to cope with high concentrations of lead and other solid ash forming components, a similar plug was run in the CFR engine under the same conditions, except that the mixture strength was 30% rich and the fuel was a motor gasoline with an addition of 9 cc pure tel per imperial gal (no ethyl bromide) and 2½ g (dry weight) of graphite per imperial gal.

This graphite was added in a colloidal compound with lubricating oil.

It appeared that the voltage was not considerably lower than in the foregoing test, which was probably due to the high conductivity of the graphite and metallic lead deposits on the insulator, but again no correlation between voltage and resistance could be observed and great variations in resistance were apparent.

After 18 hr of running the voltage was still nearly equal to that at the beginning of this rather short test.

Just for a trial the compression ratio was raised to 10/1 and soluble salycyl-allylamine-copper was added to the fuel so that it contained, besides pure tel and graphite, 2 g of copper per imperial gal. All other conditions remained unchanged and the test was continued for 2 hr more. Even under these strenuous conditions the functioning of the low-tension plug was perfectly satisfactory, although the voltage had to be increased.

During this test the amount of deposits on the spark plug appeared to be greater than in the preceding test. After the test heavy incrustations were observed on it. It is interesting to note, however, that the spark plug kept on functioning unfalteringly, even in this heavily fouled condition. At this relatively high comression ratio severe detonation was experienced. Still, preignition occurred only in the form of a few spasmodic bursts, which probably can be compared to the phenomenon called "wild ping," which is believed to be caused by incandescent incrustations within the combustion chamber.

A study of the plug after the test showed very clearly that such incandescent deposits may have been present. At the same time it is reasonable to expect that these severe detonations may have worked loose part of the deposits, so that after the

test the plug showed only the remainder. Therefore, it can be assumed that the spark plug itself did not cause preignition.

Short-circuiting the electrodes with a mixture of oil and graphite powder had no effect whatsoever upon the sparking efficiency. On the contrary, the size of the spark—which more or less takes the form of a little flame—appeared to have increased. Apparently, this form of highly intensive spark explodes such foreign material as might bridge the gap. Submerging the electrodes in water could not suppress the spark either. In fact, the entire spark plug may be submerged in water without any appreciable effect on the spark between the electrodes.

3. The ignition of very lean mixtures: under identical operating conditions, as described in the foregoing tests, the CFR engine was used for determining the lowest mixture strength at which ignition was possible. For comparison, alternate test runs were made with the low-tension and the conventional high-tension system. The test procedure included the taking of pressure diagrams, power and consumption readings, and in collecting data on optimum ignition advance when leaning out the mixture step by step until misfiring occurred.

Fig. 6 shows the results obtained with the two types of ignition systems. Whereas the leanest ignitable mixture with the conventional high-tension system showed a mixture strength of about 0.72, a mixture strength of some 0.67 could be reached with the low-tension system.

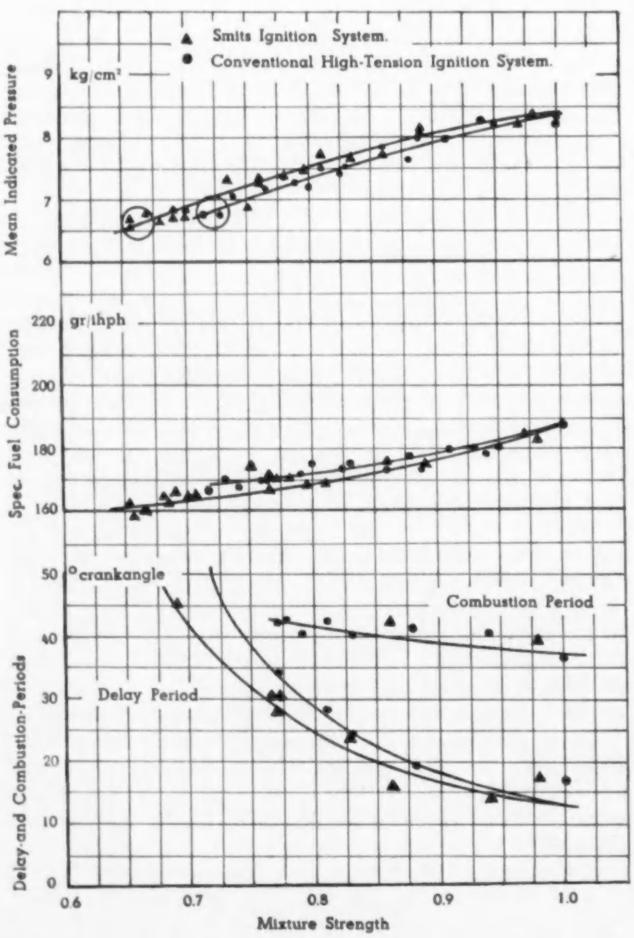


Fig. 6—Comparison of low-tension system with conventional high-tension system

Given a mean mixture strength of 0.90 (air/fuel ratio of about 16.5/1) for a multicylinder engine, it means that the deviation from mean to lowest could be increased as much as 25%. This probably helps explain the extraordinary smoothness obtained at low speeds with this type of ignition.

It is of interest to note that throughout the range of lean mixtures the low-tension system yielded slightly more favorable figures for power output, specific fuel consumption, and ignition delay. At first sight this may not be obvious but an explanation may be found by considering that the fatter spark of this capacity ignition system promotes a greater similarity of consecutive combustion cycles, which fact was borne out by actual pressure diagrams.

4. The good heat conductivity of these plugs and their ability to ignite lean mixtures makes them very attractive for aircraft engines. For this reason, tests with a single cylinder from an aircraft engine were run using several experimental spark plugs.

The plugs were subjected to alternate operation on 5 min take-off load and 10 min cruising load. A certain maximum voltage figure was preset and the tests were continued until this preset voltage was no longer sufficient for starting purposes. The first experimental plugs could stand up to 20 take-offs before the voltages had to be increased. Later types have been subjected to 60 take-offs and still function normally. The Smitsvonk aviation spark plug is still under development. Results so far obtained, however, are very promising. The particular engine was fitted with a temperature control plug in the cylinded head and it was found that this plug remained at the same temperature as the cylinder head.

It is expected that with these spark plugs very long periods of service with the lean fuel mixtures used for cruising will become possible, which hitherto caused ignition difficulties when high-tension plugs were used.

5. To show that the system is little influenced by atmospheric conditions and will operate at great heights the following test was made. A special apparatus was used in which two spark plugs can be tested at the same time. It consists of four chambers, two front and two back. The front chambers, in which the sparking sides of the plugs protrude, can be kept under constant pressure, which in this case was 100 psi. The sparking and insulator ends of the plugs can be observed during the test through glass windows. A standard commercial high-tension spark plug was used in combination with a low-tension plug with surface discharge, and both insulators were the same length. The test was started at an atmospheric pressure of 760 mm Hg to represent sea level. A sparking frequency of 500 sparks per min was kept for both plugs. The atmospheric pressure in the rear chambers was then gradually reduced, so as to establish at what pressure the plugs would cease to function normally. At a reduced pressure of 229 mm Hg, representing a height of 29,500 ft, glow discharges appeared over the insulator of the high-tension plug and the sparks in

Continued on Page 69

New Budd Diesel Railroad Car - Part III

The Power Unit

EXCERPTS FROM PAPER* BY

Vernon Schafer, Jr., Detroit Diesel Engine Division, GMC

* Paper, "General Motors 6-110 Diesel Engine for Rail Car Motive Power," was presented at the SAE National Diesel-Engine Meeting, Chicago, Nov. 2, 1950.

THE basic engine of the power unit is a 2-cycle, 6-cyl, 660 cu in. displacement General Motors diesel engine. See Figs. 1 and 2. Basic engine performance is shown in Fig. 3.

The 6-110 engine operates with cylinder block vertical in all applications except the Budd rail diesel cars. In this application, to permit underfloor mounting, the block is inclined 70 deg from vertical. The only changes made in the standard model to adapt it for satisfactory operation in the near-horizontal position was a new oil sump and drains to allow oil to return to the sump from pockets created by inclining the engine.

Any concern as to excessive cylinder wear due to the angular installation can be dismissed since the direction of engine rotation is such that the gravity force of the piston subtracts from the piston thrust.

The engine has a complete, self-contained wet sump lubricating system, consisting of a 12-gal oil sump, gear-driven gear-type oil pump, cooler bypass valve, pressure regulator, oil cooler, and bypass filters. Oil is taken by the pump from the sump through a screen and delivered to the cooler. From the cooler, the oil goes to the main gallery for distribution. Both engine and transmission oil are cooled by jacket water.

Engine cooling is accomplished by circulating water through the cylinder block and cylinder head with an engine-mounted, gear-driven centrifugal pump. Water passes through separate transmission and engine oil coolers before entering the block. These coolers are mounted on the cylinder block.

The fuel system on the engine includes the injectors, fuel oil pump, strainer, filter, fuel manifold, and connecting tubes. Fuel is drawn from the supply tank through the fuel strainer by the pump and discharged through the fuel filter to the manifold, thence to the injectors. The surplus fuel that is not used by the injector is returned through the spill line to the supply tank. This surplus fuel cools the injectors.

Air required for cylinder scavenging and combustion is supplied by a centrifugal blower mounted on the flywheel housing just above the flywheel. The forged aluminum impeller is gear driven from the camshaft at approximately 13 times engine speed. The blower maintains a charging pressure of approximately 16 in. Hg at 1800 engine rpm.

A fabricated stainless-steel exhaust manifold is bolted to the cylinder head. The manifold is well insulated to minimize heat rejection within the engine enclosure. Insulation consists of 2 in. of glass wool wound with fiber-glass tape, all enclosed by a stainless-steel radiation shield.

The cylinder block, which is the main structural part of the engine, is a box-like, one-piece casting with rugged transverse members. The cylinders are bored to receive loose-ported cylinder liners. The water jacket, surrounding the dry cylinder liners, is divided into upper and lower sections, which are connected by hollow struts. Engine coolant enters the lower section and leaves at the top of the upper section through holes which register with corresponding openings in the cylinder head.

Throughout the engine, all wearing parts, such as liners and bearings, are replaceable by precision parts, thus providing maximum life of structural members and simplifying engine overhaul.

The counterweighted, 7-bearing crankshaft is a high-carbon steel forging, heat-treated for maximum strength and durability. All main and rod bearing journal surfaces are hardened. The crankshaft is drilled for full-pressure lubrication to main and rod bearings. A double vibration damper of the viscous fluid type is connected to the front of the crankshaft to limit torsional stresses to a safe value.

Malleable iron pistons are used, each fitted with four compression and two oil control rings. The top

of the piston forms the combustion chamber and is cooled by spraying oil, under pressure, to the under side of the piston crown.

Each drop-forged steel connecting rod is rifle-drilled to permit pressure lubrication of piston pin and cooling of piston.

A train of helical steel gears is located at both the front and rear end of the cylinder block. The front gear train drives the engine cooling water and fuel oil pumps. The rear gear train drives the camshaft, centrifugal blower, overspeed and engine governors.

A camshaft, used to actuate the two exhaust valves and the unit injector for each cylinder, is located near the top of the block. An accessory shaft running the full length of the block is located just beneath the camshaft.

The cylinder head is a one-piece casting which can be removed from the cylinder block as an assembly. The fuel, water, and exhaust manifolds, as well as valves, fuel injectors, and their operating mechanisms are part of the cylinder-head assembly. Two exhaust valves and a fuel injector are located in the cylinder head for each of the six cylinders.

Fuel System

Fuel is supplied to both engines from a common 250-gal tank located under the car floor. (See Panel.) A 2-gal sump is attached to the under side of the fuel tank to collect sediment and water admitted to the fuel tank. This sump, when periodically drained, minimizes water and sediment carried to engine fuel system. Fuel for both engines is taken

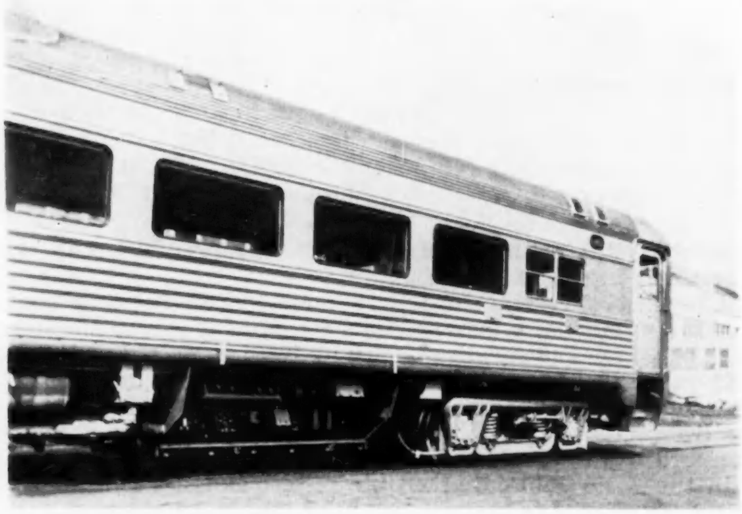
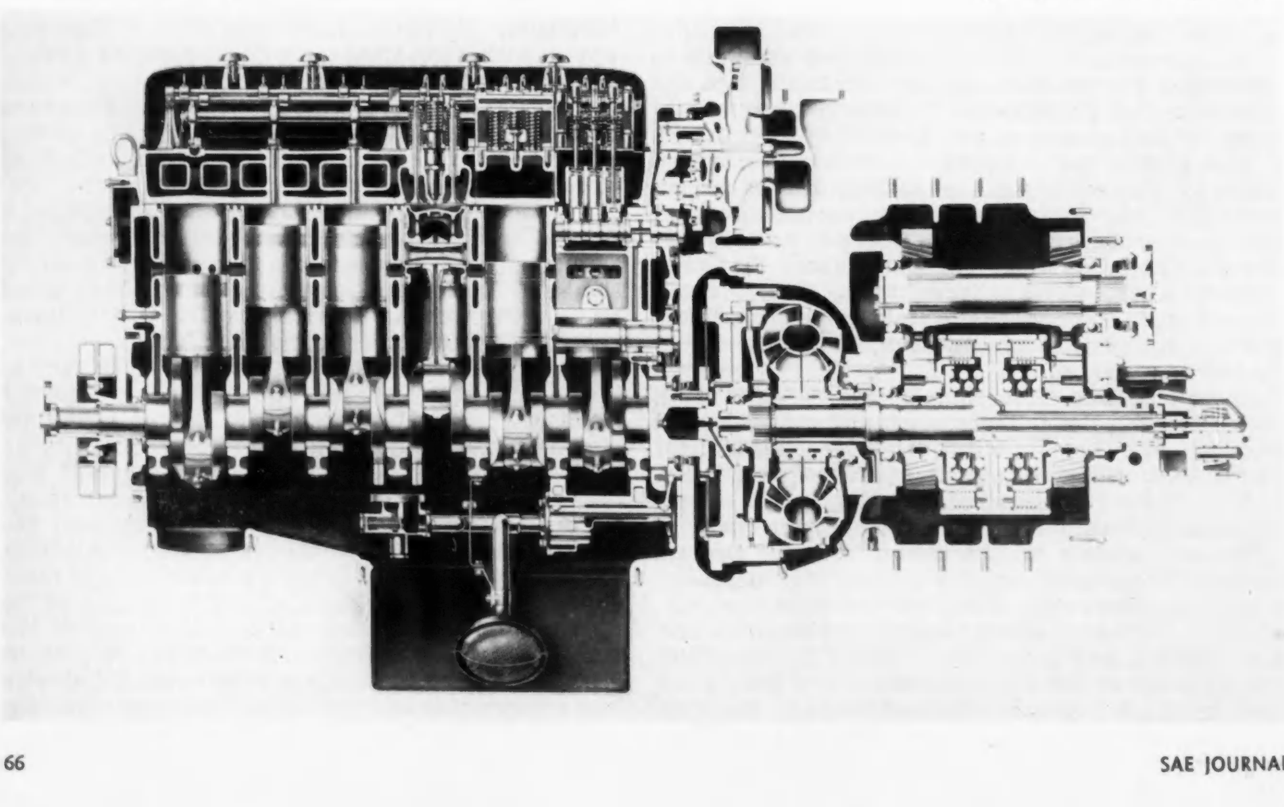


Fig. 1—Location of power unit on car

Fig. 2—Sectional view of power unit



from the tank through a standpipe from a point approximately an inch above the top of the sump. An emergency fuel cutoff valve is installed in the main feed from the tank. In case of fire, the cutoff valve can be tripped from either cab or at either fuel fill pipe. The fuel tank can be filled from either side of the car.

Air System

Engines like to breathe clean air. The air enveloping a fast-moving rail car is cleanest in the vicinity of the roof; consequently, each engine is provided with a complete and separate air system, taking air from opposite sides of the dome-shaped roof, as shown in Panel. This location of air inlet also admits air equally well regardless of direction of car motion. The compartment behind the louvered panel is baffled to prevent admission of driving rain into the down pipe, which projects through the roof sheet to act as a water guard. This pipe carries the air from the roof into an oil-bath air cleaner located beneath the car floor, as shown in Panel. Air is drawn down from the roof, through the air cleaner, and on through the horizontal run of pipe between cleaner and engine by the engine-mounted centrifugal blower. Air is discharged by the blower into the air manifold and on into the engine cylinders where it does its job of scavenging and charging the cylinders with fresh air to support subsequent combustion.

The large-sized air cleaner and piping minimize pressure loss in the air induction system.

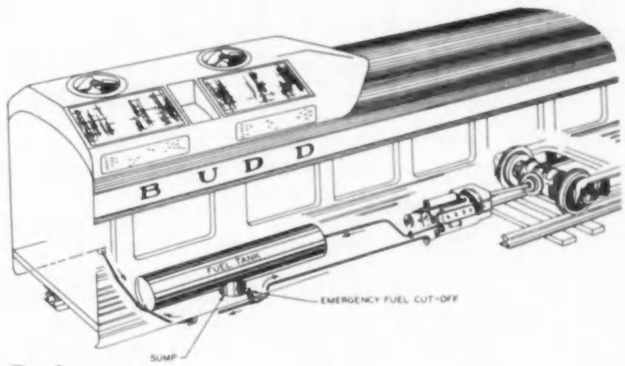
Exhaust System

Each engine has its separate and independent exhaust system. Exhaust gas discharged from the exhaust manifold passes through a horizontal run of pipe, then turns and passes through a vertically mounted stainless-steel silencer discharging at roof level, as shown in Panel. The large silencer and large diameter of connecting pipe plus the direct routing of the pipe reduces exhaust back pressure to a minimum, which is desirable from the standpoint of efficient engine performance. The horizontal run of exhaust pipe dips slightly between the engine connection and point of vertical turn. A hole is located in the bottom of the exhaust pipe at the low point to allow drainage of condensation and rain water that otherwise would collect in the exhaust system and eventually enter the engine cylinders through the exhaust valves.

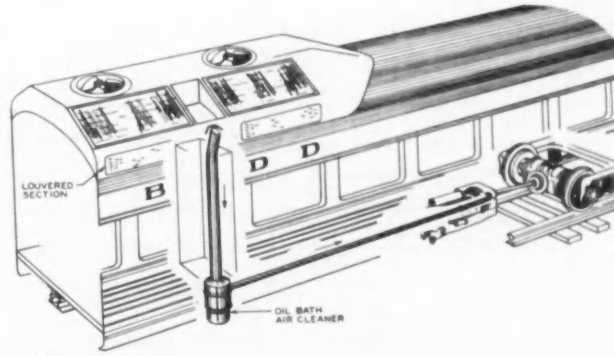
Cooling System

The prime function of a cooling system is to maintain proper engine operating temperature under the climatic conditions to which the engine is subjected. In addition to this basic requirement, namely, holding engine water temperature between 170 and 180 F, with outside temperatures ranging from – 50 to 130 F, there are other important installation requirements, such as, each engine should have its own separate and independent cooling system. This cooling system should not encroach upon revenue space; should be independent of direction of car motion; should function without the use of antifreeze; should be the source of heat for car heating;

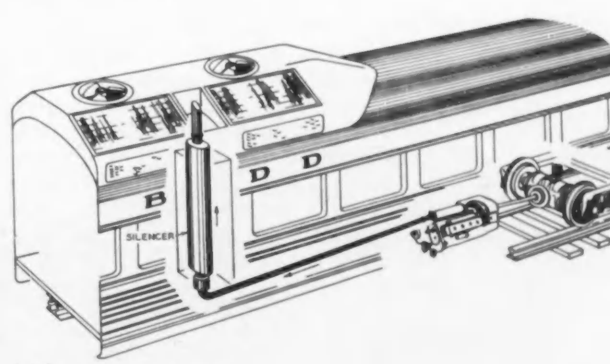
. . . Power Unit Services



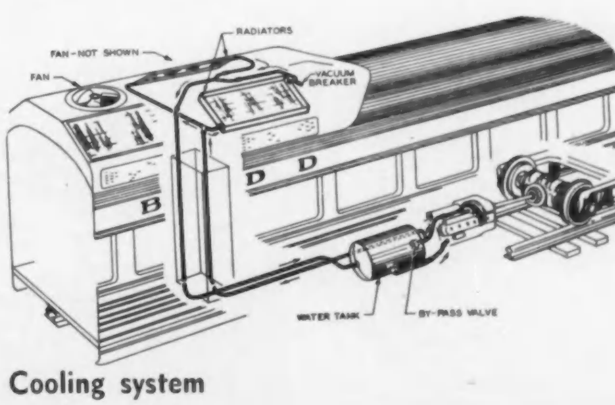
Fuel system



Air system



Exhaust system



Cooling system

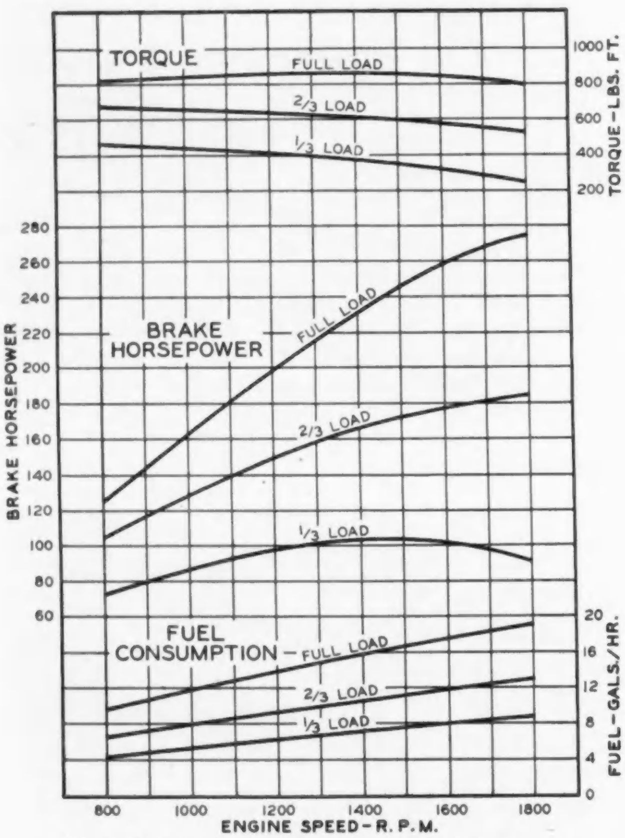


Fig. 3—Basic engine performance—GM 6-110 diesel engine

and should absorb a minimum of power in the cooling fan.

The cooling system shown in Panel satisfies these requirements. There are two of these systems per car, one per engine. Essentially, each system consists of a vented, well-lagged 75-gal water storage tank and a bypass valve located under the car floor, two radiators connected in parallel, and a 2-speed electrically driven fan mounted in the dome-like roof structure. The roof location of the radiators and fans as shown in Panel does not encroach on revenue space and their performance is independent of direction of car motion. The generous proportioning of radiators minimizes the power requirement of the cooling fans.

Operation of the cooling system (Panel) is briefly as follows: The engine-driven centrifugal pump draws water from the 75-gal tank, forces it through the separate transmission and engine oil coolers, then through the cylinder block and cylinder head, and back to the 75-gal storage tank; however, when the engine-water-out temperature reaches 180 F, a bypass valve closes, diverting the water overhead and through the radiators, then back to the storage tank. The bypass valve does not modulate the flow through the radiators. It is either full-open, meaning no radiator flow, or full-closed, giving 100% radiator flow. This action, plus self-draining, prevents freeze-up of the radiators in subzero weather and makes the use of antifreeze unnecessary. A vacuum breaker vents each radiator, ensuring quick drainage when the bypass valve interrupts the flow to the radiators.

Air is drawn through the radiators by the electrically driven 36-in. diameter fan, which requires approximately 2½ hp when operating at low speed and 5 hp at high speed. Fan action is thermostatically controlled by the temperature of the water

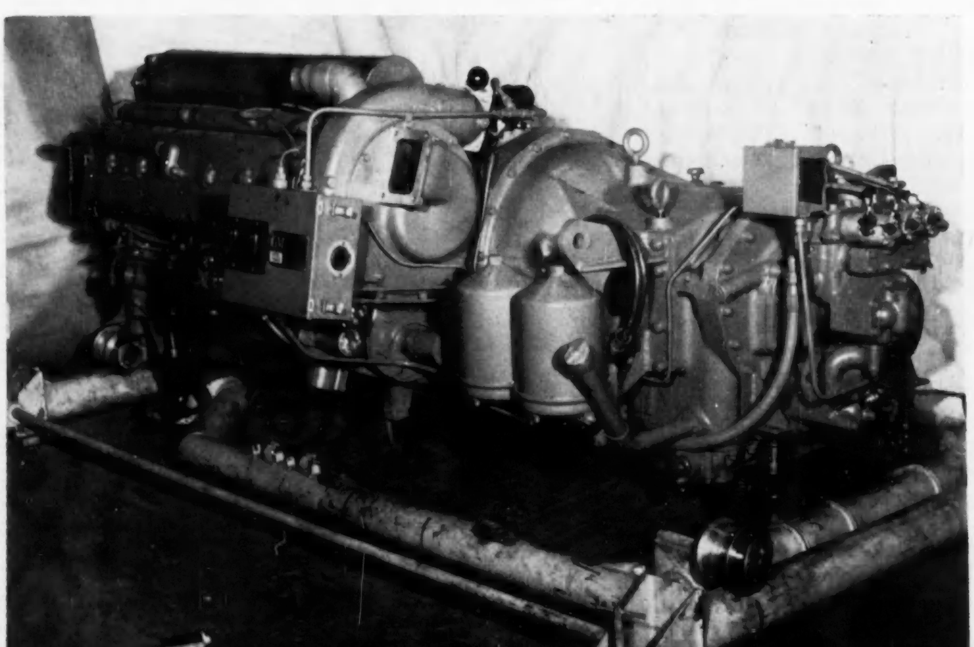


Fig. 4—Power unit and dolly. Dolly is an "L" shaped tubular assembly with three rollers and carrying three screw jacks. Jacks are attached to dolly so as to mate with three engine-transmission jacking pads. Dolly rides on a pair of tubular rails spaced by two rods

leaving the radiators. Road experience has shown that the fan operates only occasionally at high speed, even during summer operation of the cars, which indicates reserve cooling capacity.

Antifreeze protection during layover is provided by maintaining the water in the 75-gal water tank at 140 F. This is accomplished by a standby heating system utilizing yard steam, which is thermostatically admitted directly into the pipe between water tank and engine. Since the engines are not running during layover, the 140 F tank water is circulated through the engine and the car heating system by an electrically driven centrifugal water pump.

During normal operation, the sole source of car heat is that rejected by the engine and transmission to the cooling water. Although this system has worked very well on the road at temperatures of −15 F, please do not conclude that our powerplant is inefficient. Rather, the success is due to a well-insulated car plus the conservation of all the Btu's rejected to the jacket water. This conservation is accomplished by well-lagging the 75-gal storage tank as well as the water lines between the tank and the engine. Water is taken from the tank of one engine for car floor heat and from the tank of the other engine for car overhead heat. This circulation is accomplished by the same pumps used in the layover antifreeze protection.

Power Unit—Quick-Change Feature

It is intended that only adjustments and minor repairs be made with the power unit in its under-the-car position. Major overhaul items, such as replacement of rings, liners, and bearings, can be accomplished with the unit in place; however, by so doing, the car must be taken from service. Power unit location and connections were designed to enable quick change of the complete unit. A unit can be removed and another installed in 2 hr. By virtue of this feature, it is unnecessary to interrupt the car's revenue runs because of scheduled preventive maintenance or emergency repairs of the power unit.

The quick change is made possible by the use of quick disconnects for all engine services, simple attachment of the power unit to car body, and a special dolly for handling the power unit. Quick disconnects for engine services consist of fire-hose-type water connections, self-sealing disconnects in the fuel lines, toggle clamp connectors for air and exhaust, and plug-type electrical connectors for the control circuits. Three-point rubber suspension is used to attach the engine and transmission unit to the car. Two of the connections are made by two bolts at the transmission hangers (Fig. 4) and the third is a stirrup which swings under a bracket attached to the front of the engine. The dolly is an L-shaped tubular assembly with three rollers and carrying three screw jacks. The jacks are attached to the dolly so as to mate with three engine-transmission jacking pads. The dolly rides on a pair of tubular rails spaced by two tie rods. (See Fig. 4.)

The first step in removing a power unit is to demount the box enclosing the unit. This requires only a few minutes. Next, the generator and main drive shaft flanges are unbolted. After water, fuel, air, exhaust, and electrical services have been disconnected, the dolly rails are placed transversely on the track rails under the power unit. The dolly is then placed on its rails and rolled under the unit until the jacks are directly under the engine and transmission jacking pads. The jacks are then raised to lift the unit, thus unloading the three supports and enabling removal of the two bolt connections and swinging the stirrup free of the engine bracket. The jacks are next lowered, permitting the complete unit to be rolled out from under the car, where it can be handled by a crane. A unit is installed by reversing the above procedure.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Low-Tension Ignition System

Continued from Page 64

the pressurized chamber became uncertain and cut out altogether when the pressure in the rear chamber was further reduced. The low-tension plug kept on functioning normally and the pressure in the rear chamber was reduced to 40 mm Hg, representing a height of 65,600 ft, before the first glow discharges were noticed along the insulator of the plug. The sparking in the pressurized chamber appeared still to be normal. As the vacuum pump employed was unable to reduce the pressure in the rear chamber any more, the test had to be concluded. From this test, however, it became clear that for altitude tests other components would prove to be the critical factors. The altitude figures given should not be taken as strictly correct, for in actual flying conditions differ from those represented in this test. As a comparison between a high-tension plug and a low-tension one, this test shows, however, the advantages of the latter over the former in similar circumstances.

Special Plugs for Jet Engines

The special spark-plug construction for jet engines has an internal fuel feed. The fuel is fed on to the sparking surface. Two condensers of different capacities are used. These condensers are discharged over the spark plug in very rapid succession. The first spark breaks up the fuel on the sparking surface and vaporizes it. The second spark, which follows immediately, ignites the vaporized fuel, thereby creating big flames, which penetrate deep into the combustion chamber.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

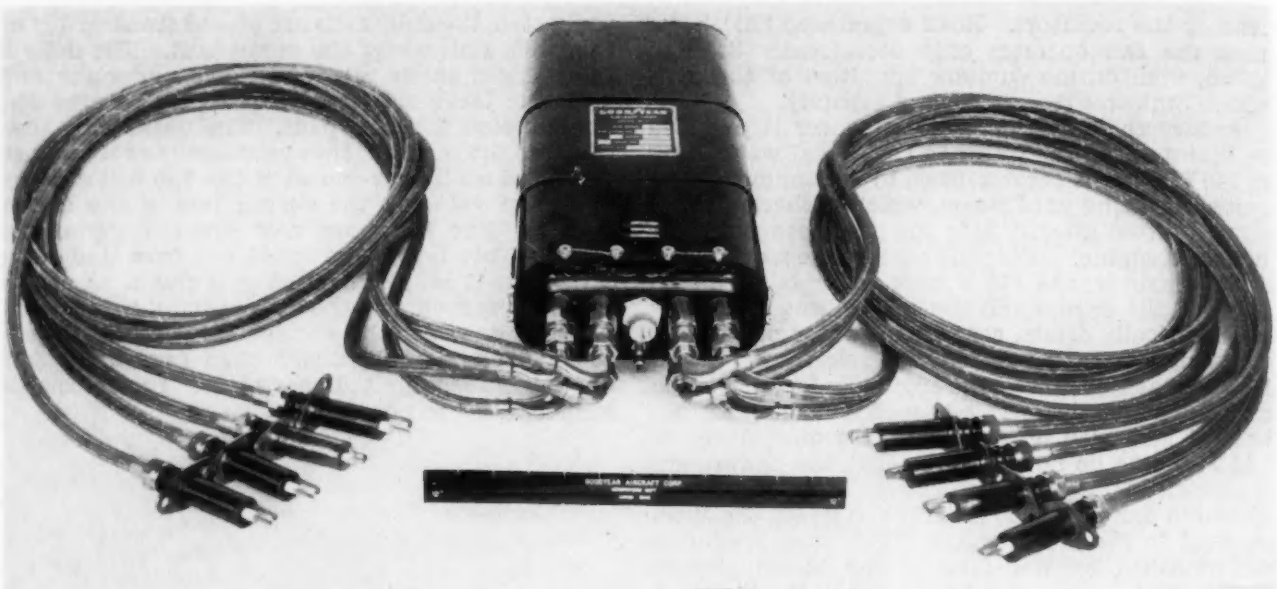


Fig. 1—This experimental high-energy ignition system for jet engines is capable of firing eight spark plugs simultaneously. It measures 4 × 8 × 16 in. and weighs 20 lb exclusive of harness and plugs

Develops Ignition System for Turbojets

Based on paper by

M. A. ZIPKIN
H. E. SHEETS
and
C. N. SCOTT

Goodyear Aircraft Corp.

UNDER static conditions ignition energy requirements increase rapidly with increasing pressure altitude above 30,000 ft. In a static test chamber, for example, the energy required to produce ignition at 75,000 ft pressure altitude is in the order of 75 times the energy necessary to effect ignition at 35,000 ft. It was also found that there is an optimum spark energy and that increasing the energy above this optimum results in decreased performance.

Similar tests in a flow tube simulating a burner inlet velocity of 100 fps indicated that the trend of increasing energy with pressure altitude found under static conditions is repeated under dynamic conditions. It was also shown that under dynamic conditions the minimum spark energy requirements are further increased above that required for static operation at a given pressure altitude. The spark energy required to initiate combustion at a simulated pressure altitude of 40,000 ft and a burner velocity of 100 fps was 3.55 times as great as the energy required to effect ignition under static conditions at the same pressure altitude. When the pressure altitude was increased to 55,000 ft, energy required for ignition at a simulated burner inlet velocity of 100 fps was 2.16 times as great as for static conditions. Over the range of pressure altitudes and velocities investigated, no optimum value of spark energy was found to exist.

An experimental ignition system was developed on the basis of the spark energy requirements indicated in the static and dynamic investigations. Tests of this system in a two inch flow tube indicated that the system was capable of initiating combustion to a pressure altitude of 55,000 ft and to simulated burner inlet velocity of 160 fps. At lower pressure altitudes the maximum simulated burner inlet velocity is proportionately greater. A comparison of the performance of this system with a commercial transformer system indicated that the high energy system would effect ignition to a much higher altitude, simulated burner inlet velocity, and over a wider range of fuel-air ratios.

Advantages

The experimental ignition system in addition to having high energy had these features:

- It was capable of firing an arbitrary number of spark plugs.
- It would permit locating a spark plug in each burner.
- It had no moving parts.
- It would fire fouled plugs.
- A shorted or damaged plug did not affect the operation of the other plugs.
- It can be made insensitive to large input voltage fluctuations.
- It was relatively unaffected by long ignition leads.
- The low repetitive rate permits operation with the same power input as used by conventional low-energy high-repetition rate systems.

(Paper "High-Energy Multiple-Spark Ignition Systems for Jet Engines," was presented at SAE Annual Meeting, Detroit, Jan. 10, 1951. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Naval Propulsion Machinery Progresses

Based on paper by

CAPT. W. P. MOWATT, USN

U. S. Naval Station, San Diego

PROGRESS in fabrication and in the use of metals and materials will bring considerable improvement in the size, weight, and quietness of both propulsive and auxiliary type machinery.

Boilers will be smaller in size, pressure fired with forced circulation, and as materials improve we can look forward to gas turbine installations. Within a few years we will have submarines with higher underwater speeds for much longer durations of time. The use of hydrogen peroxide and

liquid oxygen cycles is being developed rapidly and will permit longer submergence. More vessels will be equipped with automatic controls, which, as they become more reliable, may reduce the number of operating personnel now required.

Automatic controls, higher speed prime movers, gas turbines, and other new engineering units will require more highly skilled personnel. Thus, increased engineering education will be necessary for officers and technicians if these complex systems are to be understood, operated, and maintained properly.

Steam Gains Made Since 30's

Since the building of the Mahan class destroyers (early 1930s), steam pressures have increased from 400 to 1200 psi, and steam temperatures from 650 to 950 F. Higher figures have been obtained in experimental units. The pound weight of the steaming boiler per pound of equivalent evaporation has decreased approximately 33 1/3%, while the boiler box cubic volume per pound of equivalent evaporation has decreased about the same. Since pressures and temperatures continue to increase, natural circulation and forced circulation boilers will remain in competition, until such time as radical departures clearly establish dominance.

The use of double reduction gears in 1933 permitted full power turbine speeds of about 6000 rpm for high pressure and about 5000 rpm for low pressure turbines. There has been a gradual increase in rotative speeds and still higher speeds are projected. The trend in naval reduction gears is toward the lighter highly loaded gears.

The Navy has worked with gas turbines, but until there has been further development they cannot be considered a competitor for a marine steam plant.

A combination steam and gas cycle interests the Navy keenly. Statistics show that a destroyer travels 75% of the time under 20 knots, 22% of the time between 20 and 24 knots and only 2% of the time above 24 knots. Therefore, why not have a small steam plant for speeds up to 20 knots and a group of gas turbines that float on the line and can be cut in for higher speeds? This would give high efficiencies and maneuverability at low powers, and high powers when needed. The gas turbine can be built light since its life in hours of actual operation need not be long. The steam plant can be of conventional type, relatively low in power, thus saving in size and weight. Studies of this combination cycle have been made and the idea seems worthy of further investigation. (Paper "Trends in Naval Propulsion Machinery" was presented at SAE San Diego Section, Nov. 6, 1950. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

What Equipment Is Most Economical?

Based on paper by

WARD L. BENNETT

Baltimore Transfer Co.

LINN EDSALL

Philadelphia Electric Co.

HARVEY H. EARL

United Parcel Service of N. Y., Inc.

Ward L. Bennett:

Basically, any thought of mechanizing maintenance operations is motivated by a desire to reduce costs, or at least to hold present cost levels. Proper methods and procedures may very possibly produce as satisfactory results as the use of certain mechanical equipment.

Efforts to produce economies should begin with a detailed study of the different jobs in relation to the general operating conditions of the business. Time studies of the various tasks should then follow. Consideration should next be given to the frequency at which the various operations are required. The best results can be achieved only by constant analysis of the work and a continuing search for improved techniques. A most certain way to produce economies is to minimize the necessity for bringing units into the shop. Once a vehicle enters the shop it means expense even to move it from one place to another.

Linn Edsall:

In many instances the purchase of equipment for the shop can be justified only because it can and will be used on repair and overhaul work, as well as on preventive maintenance, running repairs, and daily servicing.

For a fleet of not too large concentration, operating at medium or low mileage, a very satisfactory P.M. and running repair program can be carried out if the shop is equipped with portable lubrication equipment, jacks, trestles, creepers, exhaust analyzer, ammeter, voltmeter, battery tester, condenser tester, gages for pressure, compression and vacuum, a tachometer, cam angle meter, timing light, plug tester and cleaner, torque wrench, light camber-caster gage, toe-in measuring device, and headlight tester.

Harvey H. Earl:

In mechanizing a shop, an operator must first determine how much of his repair and overhaul he is going to do with his own facilities. Even in established shops a review should be made periodically to determine whether changed conditions may warrant a change in policy. The decision may vary anywhere from doing all the work or none of it, depending upon the following factors:

1. Number of vehicles owned.
2. Type and variety of vehicles.
3. Location of vehicles — concentrated or scattered.
4. Outside services available.
5. Cost and complication of operating own facilities.

The mechanical part of a shop setup is only one part. No machine is better than the man who operates it, and how he runs it depends upon his skill, attitude, and supervision. Many a fine piece of equipment stands covered with dust because it is easier to send work out than to train and supervise a man to operate it. Many a piece of equipment is idle because basic principles were ignored or incorrectly applied and it is economically unsound to operate it.

(Paper "Mechanizing the Garage and Shop from an Economic Standpoint" was presented at SAE Annual Meeting, Detroit, Jan. 12, 1951. It is available in multilithographed form from SAE Special Publications Department. Price 25¢ to members, 50¢ to nonmembers.)

Methods of Engineering Involute Splines

Based on paper by

GEORGE L. McCAIN

Chrysler Corp.

(This paper will be published in full in SAE Quarterly Transactions.)

THIS paper presents the two phases involved in the engineering of involute splines. The first phase is the development of a standard which will be adaptable to most situations where it is desirable to use splined parts. The second phase covers the standard and methods of using the data in the design of parts involving splined holes or shafts on which splines are cut.

In this paper there are tables with data and dimensions which may be applied directly to experimental or custom built parts where gages and production checking means are not available. (Paper "Engineering of the Involute Spline with Data and Methods Supplementing the Standard, Including Intermediate Tables for Experimental Engineering and a Few New Convenient Formulas" was presented at SAE National Meeting, Detroit, Jan. 12, 1951. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

TECHNICAL COMMITTEE *Progress*

SAE Technical Board

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ICI Committee Continues Headlamp Comparison Tests

By P. J. KENT

SAE Representative on U. S. National Committee of International Commission on Illumination

THE question of American versus European types of headlamps is still before Technical Committee 23 of the International Commission on Illumination. Also on the agenda is development of photometric specifications for other vehicle lamps.

ICI formulates standards on technical problems in the lighting field for the International Standardization Organization. Belgium, France, Germany, Great Britain, Italy, the Netherlands, Switzerland and the United States have representatives on ICI Technical Committee 23.

The Committee met at Turin, Italy, from September 27 to 29 to study and compare American and European headlighting equipment. Delegates could not settle on a headlamp beam to recommend to ISO, but they did agree on a series of selection tests to help them make their final decision.

Committee members felt that results of tests of the two types conducted at Zandvoort, Holland, had little meaning because the so-called European lighting equipment was not truly representative of European practice and because of lack of calibrated replacement parts for European equipment that failed during test.

The committee decided that a European Subcommittee consisting of one representative from each represented European nation—not including Great Britain—will select by means of photometric and static tests a headlamp to represent European equipment. An English-speaking subcommittee will select the headlamp to represent the sealed-beam type of equipment. Enough calibrated optical units of each type are to be provided so that burn-outs will not interrupt tests.

Final comparative tests are to be made in the United States by the driving or dynamic test method.

One important result of the discussions at Turin was recognition by various European representatives that overall visibility is improved by increasing illumination on the road at a relatively long distance from the front of the vehicle, even at the expense of some increase in glare. That is, overall visiiblity can be improved by increasing the ratio of illumination to glare.

When the International Standardization Organization met in Paris, October 9-14, it assigned to the ICI committee development of photometric specifications for turn signals, stop lamps, tail lamps, and marker lamps. Besides this lighting and signalling equipment, ISO automotive groups are working on other electrical equipment, particularly spark plug threads and hex sizes, and on mechanical equipment, particularly brakes.

Aim of all ISO automotive standardization work is to

1. Facilitate international travel.
2. Facilitate international commerce.
3. Increase safety of automotive travel by standardizing signals.

Unlike most American technical standards organizations, ISO includes enforcement authorities among its representatives as well as engineers and scientists. Before a specification they develop becomes an International Standard, it must be accepted by all countries participating in ISO. If a majority approves—but not all countries—the specification becomes an International Recommended Practice.

(Ed. note: The above article is a summary of a report Mr. Kent presented to the SAE Technical Board on his return from the ICI and ISO meetings.)

P. J. Kent, chief engineer of Chrysler Corp.'s Electrical Division, represents SAE on the U. S. National Committee of the International Commission on Illumination

Approved and Proposed Aero Material Specs

TWENTY-NINE revised SAE Aeronautical Material Specifications were approved recently by the SAE Technical Board. Three new and 13 revised specifications are being circulated to industry for comment and criticism by the SAE Aeronautical Material Specifications Division.

a. The revised approved specifications are:

- AMS 4500C, Copper Sheet and Strip, Soft Annealed
- AMS 4505C, Brass Sheet and Strip, 70Cu-30Zn, Annealed
- AMS 4507C, Brass Sheet and Strip, 70Cu-30Zn, Half Hard
- AMS 4508A, Brass Sheet, Laminated, 65Cu-35Zn
- AMS 4510C, Phosphor Bronze Sheet and Strip, 95Cu-5Sn, Spring
- AMS 4520D, Bronze Strip, 89Cu-4Sn-4Pb-2.3Zn
- AMS 4544A, Nickel-Copper Alloy Sheet and Strip, Corrosion Resistant 67Ni-30Cu, Annealed
- AMS 4555B, Brass Tubing, Seamless, Light Annealed
- AMS 4558A, Brass Tubing, Seamless, 66.5Cu-31.9Zn-1.61b, Drawn Temper
- AMS 4665A, Silicon Bronze Tubing, Seamless, 95.8Cu-3.2Si, Annealed
- AMS 4701A, Copper Wire, Annealed
- AMS 4710B, Brass Wire, Tinned, Annealed
- AMS 4712A, Brass Wire, 65Cu-35Zn, Annealed
- AMS 4713A, Brass Wire, 65Cu-25Zn, Eighth Hard
- AMS 7470, Bolts and Screws, Steel, Corrosion Resistant, Heat Treated Roll Theaded
- AMS 5032A, Steel Wire, 0.18-0.25C (SAE 1020)-Annealed
- AMS 5040E, Steel Sheet and Strip, Low Carbon, Deep Forming
- AMS 5042E, Steel Sheet and Strip, Low Carbon, Forming
- AMS 5044C, Steel Sheet and Strip, Low Carbon, Half Hard
- AMS 5045B, Steel Sheet and Strip, Low Carbon, Hard
- AMS 5060B, Steel, 0.13-0.18C (SAE 1015)
- AMS 5070B, Steel, 0.18-0.23C (SAE 1022)
- AMS 5077A, Steel Tubing, Welded, 0.21-0.28C (SAE 1025)
- AMS 5080B, Steel, 0.32-0.38C (SAE 1035)
- AMS 5122B, Steel Strip, 0.89-1.04C (SAE 1095)-Hard
- AMS 6325C, Steel, 0.55Ni-0.5Cr-0.25Mo (0.38-0.43C) (SAE 8740) Heat Treated (105,000 TS)
- AMS 6327C, Steel, 0.55Ni-0.5Cr-0.25Mo (0.38-0.43C) (SAE 8740) Heat Treated (125,000 TS)
- AMS 6470D, Steel, Nitriding, 1.8Cr-0.35Mo-1.15al (0.38-0.43C)
- AMS 6480A, Steel Nitriding, 0.65Ni-1Cr-1Mo (0.32-0.38C)

b. The new proposed specifications are:

- AMS 2473, Protective Treatment for Aluminum Base Alloys (Rinse Process)
- AMS 5679, Alloy Wire, Corrosion and Heat Resistant Nickel Base-15.5Cr-8Fe, Cold Drawn
- AMS 5733, Steel, Corrosion and Heat Resistant 26Ni-13.5Cr-3Mo-1.8Ti

c. The proposed revised specifications are:

- AMS 2430A, Shot Peening
- AMS 2450B, Sprayed Metal Finish, Aluminum
- AMS 2481A, Phosphate Treatment (Anti-Chafing)
- AMS 2485A, Black Oxide Treatment
- AMS 2503A, Black Finishing, Low Baking
- AMS 2810B, Identification of Natural and Synthetic Rubber Materials
- AMS 3214E, Synthetic Rubber, Aromatic Fuel Resistant (35-45)
- AMS 3301A, Silicone Rubber, General Purpose (35-45)
- AMS 3303B, Silicone Rubber, General Purpose (55-65)
- AMS 3500B, Leather, Chrome Retanned Fuel and Hot Oil Resistant
- AMS 7228B, Steel Rivets, Corrosion Resistant, 18Cr-8Ni
- AMS 7232A, Rivets, Alloy, Corrosion and Heat Resistant, Nickel Base 15.5Cr-8Fe
- AMS 7245A, Inserts, Thread Form, Corrosion Resistant Steel

Aero Utility Parts Group Praised for Military Report

WORK of SAE's Aeronautic Committee on Engine and Propeller Standard Utility Parts, recently, was commended highly by the Aircraft Industries Association in a letter written Feb. 2 to Committee Chairman J. D. Clark of the Navy Department's Bureau of Aeronautics. J. H. Sidebottom, secretary of the AIA's Engine and Propeller Technical Committee wrote Chairman Clark as follows:

"At their 30 January meeting, the Engine and Propeller Technical Committees reviewed a report of the SAE Committee E-25 activities for the past year. It was the unanimous opinion of the Committees that your group should be complimented for the very excellent work which has been accomplished over the past three years.

"The report for 1950 is significant in that it demonstrates the great contribution which the Committee E-25 program is making to increase the use of common standards in the engine and propeller utility parts field. The Committees have asked that I express to you and each of the Committee E-25 members their sincere appreciation for your untiring efforts in this program. You may be assured that the Engine and Propeller committees recognize the substantial benefits to be derived from this program and the necessity for accelerated effort in this field particularly during the present emergency."

The SAE report commended by AIA was the basis of a report submitted recently by AIA to the military services. The AIA report showed that the SAE group (E-25) during 1950 coordinated and received approval for about 150 new aircraft engine and propeller utility parts standards, representing over 15000 stock items. These standards, the AIA report said, followed the pattern previously set down by the E-25 committee, using 6-digit, nonsignificant part numbers.

More than 13,320 man-hours of committee-personnel work were required to achieve these excellent results. Within the next few months, the AIA reported to the military, SAE E-25 will coordinate, release and publish 20 more standards.

Serving with Chairman Clark on the SAE committee are: Vice-Chairman W. P. English, Fairchild Engine Division; W. B. Billingham, Hamilton Standard Division; G. Garvelli, Wright Aeronautical Corp.; G. N. Cole, Pratt & Whitney Aircraft; H. W. Epler, Lycoming Spencer Division, AVCO Mfg. Corp.; H. M. Favor, Aeroproducts Division, GMC; G. M. Garcina, Allison Division, GMC; D. L. Kidd, Aircooled Motors Corp.; F. H. Norriss, Westinghouse Electric Corp., Aviation Gas Turbine Division; J. B. Reese, Curtiss-Wright Corp., Propeller Division; R. C. Rethmel, MCREXU-55, Engineering Standards Section, Air Materiel Command.

Iron and Steel Technical Committee Chairmen

HERE are the seven men who have led SAE Iron & Steel technical committee work through 27 of the 42 years such work has been going on. Frank P. Gilligan of Henry Souther Engineering Co. (seated, center) chairmanned the Iron & Steel Division of the old SAE Standards Committee from 1919 through 1924 and from 1931 through 1945.

Then W. P. Eddy of Pratt & Whitney Aircraft (seated, right) took over as the first chairman of the renamed SAE Iron & Steel Technical Committee upon the formation of the SAE Technical Board in 1946. Each chairman since then has served for one year. E. H. Stilwill of Chrysler, 1951 chairman, is seated at left.

Standing are: (left to right) G. C. Riegel of Caterpillar (1947); Muir L. Frey of Allis-Chalmers (1950); Roy W. Roush of Timken-Detroit Axle (1949); and Frederick C. Young of Ford (1948).

Only four other men were chairmen of the old Iron & Steel Division which came into being in 1910. Henry Souther (deceased), founder of the company which bore his name and SAE president in 1911, was chairman from 1910 through 1914; K. M. Zimmerschied of New Rochelle, N. Y., carried on from 1915 through 1917; H. L. Greene, then with Willys-Overland, was chairman in 1918; and J. M. Watson, Ingersoll Steel, from 1925 through 1930.

Lower-Alloy Series Replace SAE 4XXX, 86XX

FOUR new lower-alloy steel series are under way to alleviate the increasing alloy shortage.

Two new series, 81XX and Modified 86XX, are reduced-molybdenum but higher-chromium steels which the SAE Iron and Steel Technical Committee and the American Iron and Steel Institute have approved as temporary replacements for SAE 4XXX and standard SAE 86XX steels, respectively. The other two new series, 80BXX and 81BXX—also approved by ISTC and AISI—are boron steels.

Because of their temporary nature, these series are not being submitted to the SAE Technical Board for approval as standard SAE steels. However, it is expected that the boron series may be submitted later, if and when experience confirms the value of the steels.

The 81XX and Modified 86XX steels are expected to begin to replace SAE 4XXX and standard SAE 86XX steels immediately and to serve for the next few months until boron steels are better understood. The 81XX steels have 0.08-0.15% Mo, 0.30-0.55 or 0.35-0.60% Cr, 0.20-0.40% Ni, 0.70-1.00 or 0.75-1.05% Mn, and 0.20-0.35% Si. The Modified 86XX steels have 0.08-0.15% Mo, 0.55-0.80% Cr, 0.40-0.70% Ni, 0.70-1.00 Mn, and 0.20-0.35% Si.

Production Begun

The new 80BXX and 81BXX boron steels are already in early stages of production. The 80BXX series is designed to have hardenability equivalent to the SAE 86XXH steels at the same carbon content. The 81BXX series is designed to have hardenability equivalent to the SAE 41XXH series at the same carbon content. One additional new boron steel, 94B17, is designed to have hardenability equivalent to SAE 4820H.

These boron steels can be expected to have 0.0005% minimum boron content. Reason for the boron is that this element intensifies the effects of the other alloying elements. A little boron can do the work of considerable amounts of manganese, nickel, chromium, and molybdenum. Boron is plentiful and readily available to American steelmakers; the other alloying elements are scarce here.

At the ISTC meeting, steel producers said that samples of 80BXX and 81BXX are available to steel consumers on request. So are hardenability bands. Steelmakers hope that customers will make sample parts to experiment with processing and for service testing.

Compositions Available

Tables of chemical compositions for the new steels are available in pamphlet form from the American Iron and Steel Institute, 350 Fifth Avenue, New York I, N. Y.

Chances are that the list of boron steels will grow. At a meeting of ISTC Division VIII on March 10, one committee member reported favorably on 43B17 as a substitute for SAE 4820. He said that over the last five years, his company has made 50 tons of production truck parts from 43B17, and they haven't had a failure yet although two comparable SAE 4820 parts failed. Another member told of using 94B20 successfully in place of SAE 4620 in hypoid gears. A third recommended 43B10 as a substitute for SAE 9310.

■

A NEW, up-to-date listing of Coordinating Research Council reports is now available. Free copies of the checklist may be obtained by writing to Special Publications Department, Society of Automotive Engineers, 29 West 39th Street, New York 18, N. Y.

CALENDAR

Central Illinois—April 10 and 11

Hotel Pere Marquette, Peoria. Special Feature: 1951 Earthmoving Industry Conference.

Chicago—April 10

Hotel Knickerbocker, Chicago; dinner 6:45 p.m. Meeting 8:00 p.m. Steel—Its Manufacture and Application. Panel: L. S. Marsh, retired manager, department of inspection and metallurgy, Inland Steel Co.; P. R. Wray, metallurgical engineer, United States Steel; Maurice N. Landis, manager, metallurgical and research department, LaSalle Steel Co.; Joseph G. Althouse, metallurgical engineer, Lukne Steel Co.; E. F. Ludeen, assistant to manager, quality control department, Inland Steel Co. Special Feature: Social Half-Hour 6:15-6:45 p.m.

Cleveland—April 9

Hotel Mayflower, Akron; dinner 6:30 p.m. Some Observations on Engineering Management—James Zeder, director of engineering and research, Chrysler Corp.

Dayton—April 17

Ternstadt Division, GMC, Columbus; plant inspection 7:00 p.m.

Detroit—April 16 and 30

April 16 — Rackham Educational Memorial Building, Detroit; dinner 6:30 p.m. The Payoff in Research—C. G. A. Rosen, Caterpillar Tractor Co. Special Feature: Jet-powered miniature car race—entries by Student Branches.

April 30 — Rackham Educational Memorial Building, Detroit; dinner and meeting. Panel on Automotive Components. Moderator: E. S. Agni, Packard Motor Car Co. Speakers: C. H. Key, Ford Motor Co., R. H. Mandy, Kaiser-Frazer Corp., A. F. Welch, Cadillac Motor Car Division, GMC. Special Feature: Junior Group meeting.

Milwaukee—May 4

Fairbanks, Morse & Co., Beloit; plant trip 1:30 p.m.

Wagon Wheel, Beloit; Social Hour 6:00, dinner 6:30 p.m. Meeting 7:30 p.m. Stiffness of Cast Alloy Crankshaft—J. D. Swannack, Fairbanks, Morse & Co. Metallurgy of Casting of Case Alloy Crankshaft—R. O. Johnson, Fairbanks, Morse & Co. University of Wisconsin Student Group will attend dinner and evening session as guests.

Mohawk-Hudson Group—April 11

Albany Airport, dinner 6:30 p.m. Government Responsibility in Aviation Safety—E. N. Morey, aviation safety agent, U. S. Department of Commerce, CAA.

New England—May 1

M.I.T. Graduate House, Cambridge, dinner 6:00 p.m. Meeting 8:00 p.m. Diesel Engines, Foreign and Domestic—Robert Cass, assistant to sales manager, coach division, White Motor Co.

Philadelphia—April 11

Engineers Club, Philadelphia; dinner 6:30 p.m. Meeting 7:45 p.m. Additive Motor Oils versus Engine Design and Operating Conditions—Carl W. Georgi, technical director, research laboratories, Quaker State Oil Refining Co. John Geniesse, technical chairman.

St. Louis—April 10

Hotel Congress, St. Louis; dinner 6:30 p.m. Meeting 8:00 p.m. Automotive Brakes — P. J. Reese, application engineer, Wagner Electric Corp.

Spokane-Intermountain—April 20

Hotel Spokane, Spokane; dinner 7:00 p.m. Meeting 8:15 p.m. Papers by students from Washington State College, University of Idaho, and Gonzaga University in competition for Section award of merit.

Wichita—April 19

Droll's Grill, dinner 6:30 p.m. Meeting 8:00 p.m. The Geology Oil Structure in Kansas—Edward A. Koester, geologist.

NATIONAL MEETINGS

MEETING	DATE	HOTEL
	1951	
AERONAUTIC and AIRCRAFT Engine Display	April 16-19	Statler, New York
SUMMER	June 3-8	French Lick Springs Hotel, French Lick, Ind.
WEST COAST	Aug. 13-15	Olympic, Seattle, Wash.
TRACTOR and PRODUCTION FORUM	Sept. 10-13	Schroeder, Milwaukee
AERONAUTIC, PRODUCTION FORUM, and Display	Oct. 3-6	Biltmore, Los Angeles
TRANSPORTATION	Oct. 29-31	Knickerbocker, Chicago
DIESEL ENGINE	Oct. 29-30	Drake, Chicago
FUELS and LUBRICANTS	Oct. 31-Nov. 1	Drake, Chicago
	1952	
ANNUAL	Jan. 14-18	Book-Cadillac, Detroit

About

WILLIAM A. ROBERTS has become president of Allis-Chalmers Mfg. Co., Milwaukee, Wis. He joined the company as a salesman in 1924, after graduation from Springfield Business College and a job with a Missouri road construction company. He became sales manager of the tractor division in 1931, and its general manager 10 years later.

WILLIAM B. BERGEN has been elected vice-president, chief engineer of The Glenn L. Martin Co., Baltimore, Md. Prior to being named vice-president by the Martin Co.'s board of directors, Bergen held the title of chief engineer since 1949.

ROBERT M. CRITCHFIELD, formerly factory manager of the Delco-Remy Division of General Motors, Anderson, Ind., has been appointed assistant general manager of GMC's Allison Division in Indianapolis, Ind. He joined the Remy Electric Division in Anderson as an engineer in 1921. Twelve years later, he became assistant chief engineer of Delco-Remy, and in January, 1936, chief engineer. He was named divisional factory manager in June, 1947.

BRIAN G. ROBBINS is now Secretary of the Institution of Mechanical Engineers in London. He succeeds Sir Henry Guy, who retired because of ill-health. Robbins was secretary of the former Institution of Automobile Engineers from 1934 until its amalgamation with the Institution of Mechanical Engineers in 1942. Then he became a member of the IME staff—and its Assistant Secretary in 1947. After serving in the Royal Engineers during World War I, he was with Vauxhall for nearly five years. In World War II, he was in the British War Office where he was concerned with technical training of Army personnel.

WILLIAM J. CUMMING is now associated with the National Production Authority as chief of NPA's new Transit Vehicle Section. He was formerly superintendent of Fleet Service Operations for The White Motor Co., Cleveland.

H. B. STONE, who, prior to this, was chief torque consulting engineer with Fuller Mfg. Co., Kalamazoo, Mich., is now product development engineer with International Harvester Co., Fort Wayne, Ind.

PAUL F. STIBBARD, who had been a chassis designer with Hoffman Motor Developments Co., Detroit, is now a mechanical engineer (product design) at the University of California, Los Alamos, N. Mex.

H. E. SOMES, who was formerly a consultant in Drummond, Mich., is now connected with the H. E. Somes Engineering & Mfg. Co., Detroit.

EMIL C. IVERSON, previously chief engineer with J. D. Adams Mfg. Co., Indianapolis, Ind., now holds a similar position with Towmotor Corp., Cleveland.

HARRY S. EGERTON is now chief production engineer with Kaman Aircraft Corp., Windsor Locks, Conn. Prior to this, he was production and design engineer with Chase Aircraft Corp., West Trenton, N. J.

D. W. DEAMER, who, prior to this, was a mechanical design engineer with Douglas Aircraft Co., Inc., Santa Monica, Calif., is now employed as a project engineer in the advanced engineering department of the International Harvester Co., Fort Wayne, Ind.

MORRIS CRANDALL is now general manager of the Paraland Oil Co., Bettendorf, Iowa. He was previously director of petroleum at the Illinois Farm Supply Co., Kingston Mines, Ill.

JAMES H. RAY, formerly owner of the Carburetor Service Co., Spokane, Wash., has sold the company which he had operated for the past 28 years.

Members

DIXON

SWANSEN

E. O. DIXON, left, has been appointed vice-president in charge of research and metallurgy, and **T. L. SWANSEN**, right, appointed vice-president in charge of manufacturing of the Ladish Co., Cudahy, Wis. One of the foremost metallurgists in the forging industry, Dixon has been with the Ladish Co. for over 20 years. Swansen joined the company in 1947 as chief engineer, and rose to the position of general superintendent in 1949. Swansen was chairman of the SAE Sections Committee in 1948, '49, and '50.

ROBERT L. CANDLISH is now supervisor of the technical services section, Ford Aircraft Engine Plant, Ford Motor Co., Chicago, Ill. He was previously engine design engineer with the Hoffman Motor Developments Co., Detroit.

GRANVILLE E. WILLIAMS is now with the U. S. Air Force in Vallejo, Calif. Prior to this, he was research engineer with Phillips Petroleum Co., Bartlesville, Okla.

HAROLD W. KLAS, formerly works manager and director of engineering with Sherman Products, Inc., Watertown, Wis., is presently service engineer with Willys-Overland Motors, Inc., Toledo, Ohio.

RALPH F. SHARD, who, prior to this, was design engineer with Goodyear Aircraft Corp., Akron, Ohio, is now employed by Consolidated Vultee Aircraft Corp., San Diego., as design engineer.

A. E. PROCTOR, JR., is now manager, chemical engineering, Tractor & Industrial Engine Division, Ford Motor Co., Highland Park, Mich. Prior to this, he was a metallurgical engineer with the same company.

E. F. POLLARD, formerly automotive service engineer with the Johns-Manville Sales Corp., New York, has been transferred to the Cleveland office of Johns-Manville.

JOHN M. O'BRIEN is now with the U. S. Air Force as deputy inspector general, Directorate of Technical Inspection, Norton Air Force Base, Calif., holding the rank of major. He was previously executive assistant and senior project engineer with the Continental Aviation & Engineering Corp., Muskegon, Mich.

W. T. STARK has recently been named executive vice-president and member of the board of directors for United Aircraft Products, Inc., Dayton, Ohio. Stark was formerly with Wright Aeronautical Corp., Wood-Ridge, N. J., where he was project engineer in charge of fuel metering and ignition, and turbine control and accessory development.

HENRY ROWOLD, a vice-president of Mack Motor Truck Corp., New York, has been appointed manager of Mack's Distributor Sales Division. Rowold's new duties entail the supervision of all Mack distributors in the United States, Canada and Mexico. He has been with Mack since 1919 and was formerly manager of national accounts in New York.

EARL E. EBY, manager of power & industrial equipment for General Motors Overseas Operations Division of GMC, has retired after 35 years service with various other GMC divisions, namely, Hyatt, Delco-Remy, Oldsmobile, and since 1927, the Overseas Division. He has been an SAE member since 1922.

ROBERT CASS, assistant general sales manager of the Coach Division, The White Motor Co., Cleveland, has assumed his new duties as chief of the Automotive Branch of the Transportation Equipment Division of the National Production Authority.

RAYMOND C. FIRESTONE, center, vice-president of The Firestone Tire & Rubber Co., Akron, Ohio, is pictured after his election to the position of chairman of the sponsoring committee of the Future Farmers of America Foundation. With him are Dr. W. T. Spanton, chief of the Agricultural Education Service of the Federal Security agency, left, and Walter Cummins, Freedom, Oklahoma, national president of the F. F. A. The 110-member sponsoring committee plans and carries out incentive and award programs for F. F. A. members in all phases of agriculture.

ANTHONY J. ZINO, JR., has been appointed assistant to the president of Swan-Finch Oil Corp., New York. Zino was promoted from sales promotion manager and chief lubrication sales engineer.

RAYMOND LOEWY is the author of "Never Let Well Enough Alone," just published by Simon & Schuster. The book is autobiographical, describing Loewy's early life in France, his gradual conception of the field of industrial designing, and his eventual entry into every phase of it . . . "from lipsticks to locomotives." Referring to SAE, Loewy calls it "the formeost organization in the industry . . . its standing and prestige known and respected throughout the world." Price of the book is $5.00.

WILLIAM F. SHERMAN is co-author with Henry M. Cunningham of "Production of Motor Vehicles," a new McGraw-Hill Book Co. publication designed to help manufacturers currently tackling the conversion of plants to military production. Both authors are on the headquarters staff of the Automobile Manufacturers Association, and Sherman is SAE Journal field editor for the Detroit Section.

The book discusses the practices, procedures, methods, job descriptions, titles, and time elements involved in the conversion problem. Illustrations and case histories are numerous in this first how-to-do-it treatment aimed at executive management levels.

JOHN MIKULAK, who, prior to this, was research engineer with the American Car & Foundry Co., New York, is now assistant to the vice-president in charge of production, Worthington Pump and Machinery Corp., Harrison, N. J.

JOSEPH GESCHELIN, vice-chairman, SAE National Production Activity, addressed the Bristol Company Engineers' Club of Waterbury, Conn., on March 6. Subject of his talk was a highlighting of all of the automatic drives now available on passenger cars, including the new Chrysler torque converter drive, slanted from the standpoint of the car owner. Adding to the interest of the presentation were cutaway models of automatic transmissions supplied by several passenger car builders.

GEORGE L. WILLIAMS, previously an analytical engineer with Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn., is presently research physicist with the research and development laboratory, Hughes Aircraft Co., Culver City, Calif. He is in charge of an analytical group on rocket motor propulsion and landing problems.

WILLIAM B. HUSBAND is now regional service manager with Willys-Overland Motors, Inc., Toledo, Ohio. He was formerly service manager of Ohio Willys Sales Co., Cleveland.

FRED O. HOSTERMAN is now connected with Weston Hydraulics, Ltd., North Hollywood, Calif. Prior to this, he was hydraulics design specialist with Lockheed Aircraft Corp., Burbank, Calif.

J. BENNETT HILL, director of chemical and engineering research, Sun Oil Co., Marcus Hook, Pa., was presented with a "certificate of appreciation" from the chairman of the research committee of the board of directors of the American Petroleum Institute at the API 30th Annual Meeting in Los Angeles. He has long been associated with the Institute's fundamental research program.

HAROLD E. WEBB has been appointed the West Coast sales and service representative of Greer Hydraulics, Inc., Brooklyn, N. Y. Webb will service the West Coast area and will handle all aviation and industrial products manufactured by Greer. These products include maintenance and test machines for conventional and jet aircraft and industrial hydraulic components such as accumulators, valves, filters, power units, and so forth.

ROBERT J. JACKSON, formerly development engineer with Lanova Corp., Long Island City, N. Y., is now a process engineer with M. W. Kellogg, Jersey City, N. J.

JOHNSON

C. V. JOHNSON, manager of landing gear and administrative engineering, has been appointed manager of the Mishawaka, Ind., plant of the Bendix Products Division, Bendix Aviation Corp., South Bend, Ind. **GEORGE W. PONTIUS,** manager of automotive engineering, will be assigned the administrative functions of landing gear engineering.

PONTIUS

E. J. HERGENROETHER, International Nickel Co., is back in Washington again on an assignment similar to the one he had during World War II. He is heading the metallurgical branch of the Steel Division of the National Production Administration. His office is in the Commerce Building.

J. EDWARD SCHIPPER is now part owner of Schipper-Webb Associates, Detroit. Prior to this, he was vice-president and manager of Kudner Agency, Inc., Detroit. Schipper was chairman of the SAE Detroit Section in 1918.

THEODORE C. LASH is now master mechanic with C. A. Morrison Knudsen de Venezuela, Caracas, Venezuela. He previously held the same position with Morrison Knudsen de Sonora, Yuma, Ariz.

LEWIS P. FAVORITE has been named manager of Aluminum Co. of America's New York district sales office. Favorite, who has been serving as product manager in charge of the sale of die castings, is a veteran of more than 23 years' service with the company. In 1948, he was appointed St. Louis district sales manager, and in October of last year was named to his most recent duties as die castings product manager.

JOHN E. NELSON, formerly chief design engineer with the Ahlberg Bearing Co., has been recalled to active duty with the U. S. Marine Corps.

DAVID WALKER, formerly chief engineer with Industrial Scientific Co., New York, is now employed by Sperry Gyroscope Co., Great Neck, N. Y.

DONALD W. WING, formerly assistant chief design engineer with Precision Scientific Co., Chicago, has been promoted to assistant manager of the product engineering department.

MAJ.-GEN. EDWARD M. POWERS, U. S. A. F. (retired) vice-president and director of engineering of Curtiss-Wright Corp., Caldwell, N. J., since 1949, has been elected a director of the company.

E. A. BONIFACE is now a designer with Lockheed Aircraft Co., Burbank, Calif. Prior to this, he was employed by American Airlines, Inc., Tulsa, Okla.

VERNON F. FISHTAHLER, formerly assistant staff engineer, suspension, wheels, tires, steering brakes, with Cadillac Motor Car Division, GMC, Detroit, is now assistant staff engineer, suspension and tracks at the Cleveland Tank Plant, Cadillac Motor Car Division, Cleveland.

CLARENCE D. JOHNSON is presently a designer with the Morris Machine Tool Co., Cincinnati, Ohio. He was previously a senior machine layout draftsman with the Cleveland Automatic Machine Co., Cincinnati. His new position entails the design of special machinery and research on new machines.

JOHN J. BRODERICK, formerly assistant section engineer with American Bosch Corp., Springfield, Mass., is now development engineer with General Electric Co., Schenectady, N. Y.

AIR COMMODORE F. R. BANKS delivered the James Clayton Lecture, "The Aviation Engine," at a General Meeting of the Institution of Mechanical Engineers on Feb. 16. The Clayton Lectures, sponsored by the British Institution of Mechanical Engineers, are designed to promote the advancement of knowledge in fields related to mechanical engineering. In this lec-

Air Commodore
F. R. Banks

ture, Banks gave a cross-section of aviation engine development and progress during the last two decades. During World War II, Banks served the Ministry of Aircraft Production as director-general of aero-engine production and later as director of engine research and development. He returned to his former position of technical manager and chief engineer with Associated Ethyl Co. in July, 1946.

SAE Members at Cadillac's Cleveland Tank Plant

SAE members now serving with General Manager **E. N. COLE** at the Cleveland Tank Plant of the Cadillac Motor Car Division of General Motors Corp. are: **C. V. CROCKETT,** assistant chief engineer; **D. M. ADAMS,** staff engineer—armament; **E. S. MOYER,** staff engineer—engine, fuel, and exhaust system; **C. A. RASMUSSEN,** staff engineer—transmission and suspension units; **S. G. LITTLE,** staff engineer, test and development; **H. G. WARNER,** assistant general superintendent of all manufacturing operations.

CROCKETT

ADAMS

MOYER

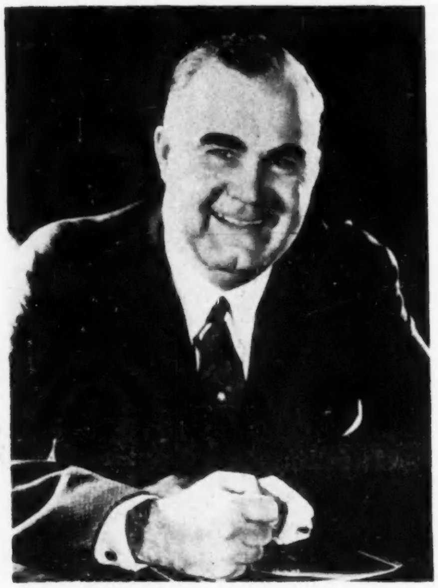
RASMUSSEN

LITTLE

WARNER

OBITUARIES

Fred Morrell Zeder



FRED MORRELL ZEDER

The SAE, the automotive industry, and the engineering profession join in paying tribute to Fred M. Zeder, vice-president of engineering and vice-chairman of the Board of Chrysler Corp., who died suddenly in Miami Beach, Fla. on February 24.

As the designer—with Carl Breer and Owen Skelton—of the original Chrysler car, as one of Walter P. Chrysler's original associates at the founding of Chrysler Corp., and as the man who created and developed the famous engineering laboratories of that organization, Fred Zeder was an industrial magnate of tremendous scope and power.

But he was far more than that!

He was one of the leaders in bringing automotive engineering out of the realm of crude, rough and tumble, guesswork methods and establishing it on a sound, organized, scientific basis. Automotive engineers everywhere owe much to him for their professional standing today.

He was also outstanding because he possessed so many of the virtues which engineers are generally accused of lacking. An eloquent speaker, as those who have heard him can attest, he was much sought-after for this purpose. His many outside interests, such as the Boy Scouts and his Church, exemplified his highly developed sense of social responsibility. And he was a great administrator. His abilities in this direction led him into the highest management circle of his corporation and established precedent for engineers in top management throughout industry.

Born on March 19, 1886, in Bay City, Mich., where he spent his boyhood, Zeder attended the University of Michigan and graduated with the degree of Bachelor of Science in Mechanical Engineering in 1909. Following graduation, he entered the apprentice course of the Allis-Chalmers Co. of Milwaukee, subsequently becoming erecting engineer in 1910. Later that year, he joined the E.M.F. Company and was soon placed in charge of its engineering laboratories. In 1913, he was appointed consulting engineer for the Studebaker Corp., later becoming chief engineer. In 1920, he left to join Chrysler who was then organizing the Willys Corp.

In 1921, Zeder formed the famous engineering triumvirate, the Zeder-Skelton-Breer Engineering Co., which in 1922 designed a low-priced quality car powered by a new type "high compression" engine. Chrysler, then chairman of the reorganization committee of the Maxwell Motor Corp., was greatly impressed with the beauty and performance of the "Zeder" car, and he made a deal for the designs and services of the complete organization and moved them from Elizabeth, New Jersey, to Detroit. When Chrysler Corp. was formed, Zeder was made a director and Vice-President in charge of engineering, and with Skelton and Breer as his associates began the development of Chrysler engineering and research. In 1935, he was elected vice-chairman of the Board in addition to his position as vice-president. Zeder has been in charge of the engineering of every Chrysler Corp. model produced since its inception, including the pioneering of many outstanding automotive developments.

During the last war, he served as special consultant to the Ordnance Department and as chairman of the Land Transportation and Armored Vehicles Committee of the National Inventor's Council. He took a particular interest in the latter activity, and it was for a meeting of this group that he was in Florida at the time of his death.

He was a member of the engineering honorary societies Tau Beta Pi and Sigma Xi, and of the American Society of Mechanical Engineers, American Society for Testing Materials, American Society of Civil Engineers, Engineering Society of Detroit, and the Franklin Institute. He received honorary degrees of Master of Engineering from the University of Michigan in 1933, and Doctor of Engineering from the University of Detroit in 1944. In 1941 he was made a Knight of Malta.

But it is not just for the high honors or the recognition of his engineering genius that Fred Zeder will be remembered. Rather will those who knew him recall his marvelous personal warmth, his great capacity for friendship and sympathy to those who needed it, and his deep religious convictions and sense of devotion to the One to whom he referred as the Master Engineer.

CHARLES G. MINOR

Charles G. Minor, vice-president of Welsh & Green, Inc., Chicago, died February 11. He was 68 years old.

Minor was born in Detroit, and received his degree in mechanical engineering from Michigan Agricultural College in 1907. He served as an engineer in the Automotive Division of the War Production Board during World War II. He had been an SAE member for 39 years.

J. R. HELLER

J. R. Heller, one of the founders of The Elco Lubricant Corp., Cleveland, died of a heart attack in Tucson, Ariz., on Feb. 8. He was 50 years old.

Heller was for many years a director, vice-president, and general manager of Elco. Due to ill health, he resigned in 1946 as general manager, but continued to be active in the business during part of each year. At the time of his death, Heller was Western district sales manager and director of the company.

He had been one of the pioneers in the hypoid gear lubricant field, and was well known in the automotive manufacturing industry.

HUBERT C. REYNOLDS

Hubert C. Reynolds, 56, who supervised production of vital fighting equipment as a member of the executive staff of Chrysler Corp., during World War II, passed away on Jan. 21.

Coming to this country as a boy from Newcastle, England, where he was born in 1894, Reynolds joined Chrysler in 1933. During World War II, he was assigned the important job of following through the development of tank engines, tank turret baskets, air raid sirens, fire fighting equipment, and other essential wartime projects.

SAE Section Meetings

Performance Qualities Of Gasoline Discussed

• Salt Lake City Group
Hal LaBelle, Field Editor

Feb. 19—**Dr. Daniel P. Barnard IV**, 1949 Horning Memorial Award winner, used a question and answer technique in discussing performance properties of gasoline before 250 members and guests of this Section.

Barnard, who is research coordinator for Standard Oil Co. of Indiana, traced the story of gasoline and its use from its earliest simple refined form to the present-day product of a highly complicated refining process.

At the turn of the century, he said, gasoline was a good choice among available sources of energy around which to develop a powerplant for the modern automobile. Against the horse, the battery electric and the steamer, it had outstanding advantages in maximum brake thermal efficiency; investment dollars per horsepower; and fuel costs per horsepower-hour. Finally, the gasoline engine offered the greatest promise of economy of manufacture because it eliminated such intermediary devices as the boiler, and "burned the fuel directly at the place where the work was to be done."

Volatility and octane number were named as the properties of gasoline that directly affect relative engine performance. Volatility defines the behavior of the gasoline up to the point of combustion; octane is a measure of its tendency to knock in the engine.

Engine design changes have permitted better performance from higher and higher octane fuels, largely because of higher compression ratios, Barnard said. However, engine roughness has accompanied higher compression ratios in general. The current trend to overcome this roughness is to design more rigidity into the engine. Rigidity in engine design permits advantages "over and above the implied increased thermodynamic efficiency resulting from increased compression ratios." These engines, he said, have also resulted in surprisingly high mechanical efficiencies.

Tracing the development of higher and higher octane gasoline, Barnard described the many refining method developments which have contributed to this progress. Among the most significant were thermal crack, tetraethyl lead, thermal reforming, and the various catalytic processes including polymerization, isomerization, cracking and reforming. The most recent is "Platforming," or reforming by catalytic action of platinum in a continuous process, still in the development stage. The sum total results of all these refining improvements were said to encompass an octane rating improvement from about 50 in 1900 to the present 90 (Research Method) for Premium gasoline. In addition, far greater yields from crude oil have been obtained—up to 45%.

Actually, as octane numbers more nearly approach 100 their actual antiknock value increases more than the octane number itself in terms of actual engine performance.

Barnard reported that research work relating to this fact has led to a new criterion termed "Relative Density Number" which gives a better evaluation of fuels below 100 octane number as regards actual engine performance. The new RDN is related to actual "density of the air in the combustion mixture just prior to ignition."

Finally, considering the economic aspect of gasoline, Barnard said "the generally downward trend of the ex-tax retail price of gasoline, relative to quality and to general commodity prices, warrants the conclusion that the research and development efforts devoted to this product and its manufacturing processes have paid real dividends to the gasoline user."

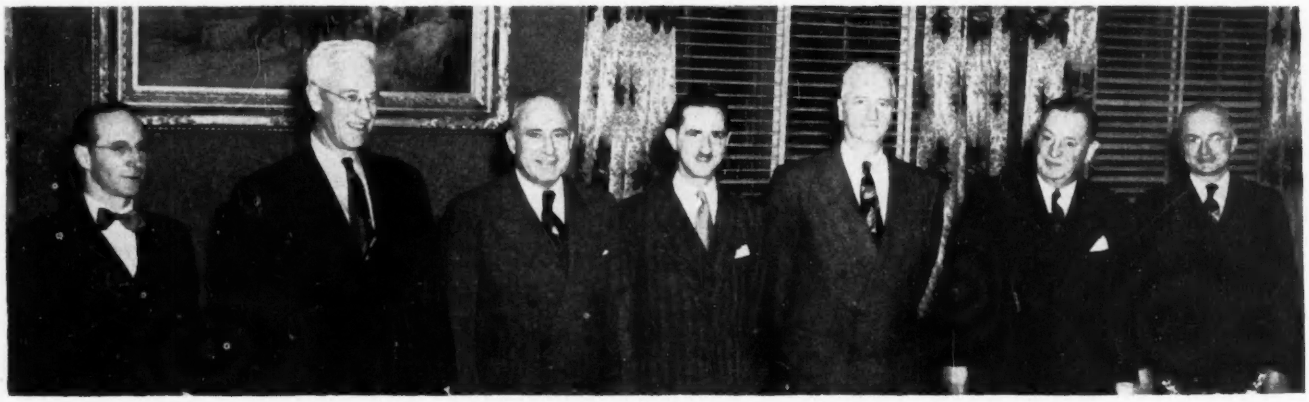
Reviews Developments In Automatic Transmissions

• Syracuse Section
David T. Doman, Field Editor

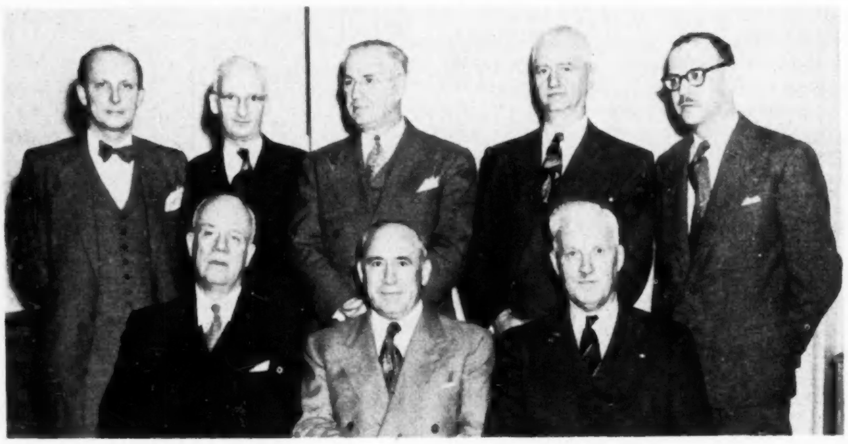
Feb. 19—**Joseph Geschelin**, Detroit Editor of "Automotive Industries," was guest speaker at Syracuse Section's largest dinner meeting. Speaking on "What's New in the Industry for '51," Geschelin covered general automotive developments for this year, then brought out individual design points of different current automatic transmissions. He pointed out that some of the automatic units have been in actual use for over 10 years. They are marvels of compact engineering, he said, made possible by an accretion of small engineering advances over a number of years.

Geschelin showed sectional cutaways of the Merc-O-Matic and Ultramatic, and a number of new cars were provided by local Syracuse dealers to acquaint the audience with the present group of automatic transmissions.

Merc-O-Matic transmission on display at Syracuse Section's Feb. 19 meeting. C. R. Armbrust of Westvale Engineering (arrow) points out interesting features



Head table guests at a recent governing board luncheon of Canadian Section, held at the Granite Club in Toronto (left to right): R. J. Renwick, chief engineer, Ford Motor Co. of Canada; Past-Chairman Warren B. Hastings; SAE President Dale Roeder; Col. Malcolm P. Jolley, present chairman; John C. Hollis, administrative division, SAE Headquarters; W. E. McGraw, chief engineer, Chrysler Corp. of Canada; and F. G. King, secretary



Shown at Montreal Section's Feb. 20 meeting are (left to right), front row: Vice-Chairman E. J. Cosford; SAE President Dale Roeder; and Secretary F. H. Moody. Back row: H. L. Eberts, arrangements; Frank B. Thompson, publicity; Frank O'Connor, entertainment and reception; John C. Hollis, SAE Headquarters; and Prof. P. M. S. Stafford, student activities

SAE President Visits Canada

• Canadian Section
A. H. Glionna, Field Editor

• Montreal Section
Frank B. Thompson, Field Editor

Feb. 20 and 21—SAE President **Dale Roeder** was guest speaker this week at Montreal and then at Canadian Section, where he discussed "Preventive Production."

"The emergency today is primarily a production emergency," he said. "Upon our ability to produce may hinge not only our system of democratic capitalism, but also the very survival of a free world. A production emergency is our kind of emergency, and it presents a challenge which SAE is well fitted to answer."

"Our countries are again called upon to become the arsenals of democracy . . . our power to produce is again the greatest hope of the free world. Only by matching or surpassing our productive efforts can Russia hope to succeed in her drive for world conquest. Our nations stand or fall on our ability to turn out the goods of war.

"We face the equally vital job of securing our own countries against inflation and economic disaster. Production is also the means for accomplishing this second job.

"The supreme task before us is to help maintain and expand the productive capacities of our countries."

He admitted that this is a tremendous task. Production is already at a peak, and there is no back-log of unemployed. Thus the extra load which defense demands will place upon the national productive machine can't help but strain it to its very foundation. But he expressed the faith that the men of business and industry will accept the challenge.

"Today, wars are won as much on the drafting board and production lines as on the battlefield, and in this strange half-war, half-peace situation, the issue might be decided only on the drafting board and along production lines. It's not overly optimistic to think that by sufficiently arming ourselves and our allies, we may prevent the struggle from becoming a full-scale test of arms."

Role of SAE

What does that mean to SAE?

"The first task . . . is to put our full resources of technical manpower and 'mind-power' at the disposal of our government agencies and armed forces . . . volunteering ourselves, our facilities, and our materials for whatever service they could perform in the defense effort."

Roeder reported that the Society's Technical Board is now working closely with national defense agencies on various defense projects and pro-

grams, and reviewed the role of SAE in the two previous World Wars.

"Since the struggle in which we are engaged today may very well continue on a limited basis over a long period of time . . . we face the problem of achieving a balance between the demands of staying power over the long pull and the demands of the extreme effort. We have the further problem of being always prepared to make a quick shift from one to the other.

"These are new problems for our nations. We know how to mobilize for total war, and we know how to produce for peace, but never before have we had to do both simultaneously. We must strive at all times to keep ourselves as flexible as possible. We must maintain and sharpen our skill at what might be called 'the science of change.' None of us should make the mistake of committing ourselves or our facilities to any program that will leave our hands tied if the situation should change overnight."

Roeder suggested that new machines, plants and equipment be designed and built so that they will be as adaptable as possible. He admitted this suggestion ran counter to the mass production philosophy which emphasizes maximum efficiency of every machine and plant, but feels that this sacrifice would be worth while in most cases, particularly in defense plants or those readily convertible to defense work.

"We might also consider reversing our normal policy to one which will favor the use of any machine or plant that is reasonably adaptable to the job at hand. In that way, we can help achieve the greater degree of flexibility that is needed."

"The ability to cast off the old and take on the new, year in and year out, is a unique and valuable service which the automobile industry and very few others can offer to our countries. We will do well to share it widely and generously."

Rotating Devices Extend Valve Life

• Buffalo Section
D. C. Appelby, Field Editor

"Commercial fleet operators can now attain the ultimate in engine service," said **Herbert C. Sumner**, Ethyl Corp., who discussed valve rotation in truck, bus and stationary engines.

"The use of rotating devices so reduces deposit formation on valve faces, seats and stems that exhaust valve life can now be made to equal piston ring life in a great many engines," Sumner declared. "For years, metallurgists and engine designers have continuously pointed for this goal. Its achievement means decidedly lower maintenance costs for the fleet operator, who can now recondition valves and install new rings during the same overhaul after he has run up 50,000 or more miles."

Pointing out that exhaust valve burning has been a limiting factor to heavy-duty engine durability since the early 1900's. Sumner cited the results of Ethyl Corp. tests which showed that normal valve life was extended two to five times when rotators were applied in 34 different commercial fleets.

Eugene Wilson Speaks; Past Chairmen Honored At Southern New England Anniversary Meeting

• Southern New England Section
Robert E. Johansson, Field Editor

Feb. 13—Eugene E. Wilson, former vice-chairman of the board of United Aircraft Corp. and recently retired chairman of the board of Aircraft Industries Association, called upon American engineers to concentrate all material and spiritual forces upon the task of safeguarding to individuals their right to freely exchange their services, goods and ideas.

Speaking to some 250 members and guests at a dinner meeting commemorating the 15th anniversary of the founding of Southern New England Section, Wilson asked American engineers to "channel technology toward the improving of human welfare," and indicated that "the announcement of some such program publicly would put those now bent upon enslaving men's minds strictly on the defensive." (Excerpts from Wilson's paper, "Engineering the Humanities," appear on page 17 of this issue.)

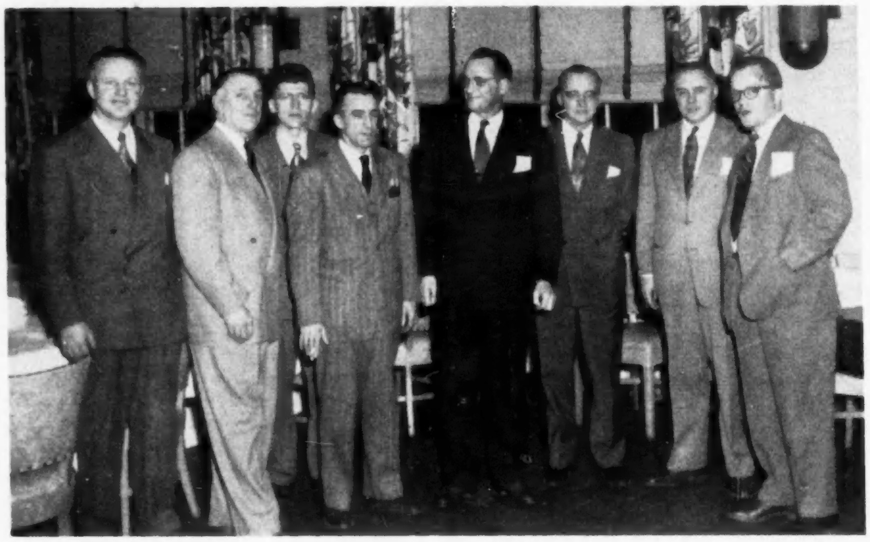
Present on this special occasion were 10 of the 15 past-chairmen of the Section, who include Wilson. Joseph Barr, president of United Aircraft Export Corp., and Francis Murphy, publisher of the Hartford Times, also were introduced as guests of honor by Acting Chairman C. Owen Broders.

Certificates were presented to Wilson, second chairman and the oldest present, and W. Paul Eddy, Jr., in recognition of their services to the Section.

Southern New England Section's Past-Chairmen

Present at the 15th anniversary meeting, Feb. 13, were (left to right): David Waite, Wallace Barnes Co.; Edward Marks and W. Paul Eddy, Jr., Pratt & Whitney Aircraft; Richard Molloy, United Aircraft Corp.; Eugene Wilson; Charles Marks, Pratt & Whitney; Prof. L. C. Lichty, Charles Phelps, and Herbert Best, Yale University; and Chester Wells, Pratt & Whitney. The five past-chairmen not present at the meeting were Rex Beisel, John Lee, Frank Gilligan, Warren Teigeler, and Kenneth Thomas

Section Members Speak at Twin City Section



• Twin City Section
W. J. Raleigh, Field Editor

Pictured at Twin City Section's annual "Home Talent Night" dinner meeting are (left to right): Wayne Schober, Viking Tool & Die Co.; Secretary S. Reed Hedges; W. J. Raleigh, of Scott-Atwater Mfg. Co.; Walter Fenton, the Metalloy Corp.; George S. Marks, Lakehead Pipeline Co.: J. V. Sigford, Minneapolis Honeywell Co.; Vern L. Scott, W. H. Barber Co.; and Chairman Frank Donaldson, Jr.

Marks, Fenton, and Sigford were speakers. Marks spoke on "The Fastest Inch," describing construction of the new pipeline from Regina, Saskatchewan to Superior, Wis.; Fenton discussed "Lithium, Its New Place in Industry," displaying samples of the metal and describing its use in lubricants for extreme temperatures and in metallurgical processes; Sigford's talk, "Minneapolis Honeywell Progresses," dealt with problems encountered in applying electronic devices to high-speed jet aircraft.

Specialists Discuss Body Testing Problems

• Detroit Section
W. F. Sherman, Field Editor

Feb. 5—"An automobile body's construction is at least as good as that of a first-class apartment house building," was one of the conclusions at the Body Technical Meeting of the Detroit Section at the Rackham Building.

Many aspects of "Body Testing for Better Automobiles" were explained by four outstanding speakers. Each gave a short, highly-condensed and informative discussion of specialized aspects of the body testing problems.

Presiding, Henry C. Grebe, of Ford Motor Company, assistant vice-chairman of the Body Activity, introduced Dr. Charles Lipson, well known consultant who was the moderator of the program. Three hundred and fifty members and guests crowded the auditorium.

L. M. Ball, head of Chrysler's sound laboratory, discussed designing and testing for quietness in a talk replete with sound demonstrations from a sound recorder. The audience participated in a series of evaluations after a preliminary demonstration of "white noise"—all kinds of noise in the audible spectrum. In certain of the tests, Ball demonstrated, audience detection was more accurate than that of meters. In other instances conflicting evaluations indicated the difficulty of obtaining conclusive indications.

Designers and stylists have profound effects on the sound engineering problem, Ball said. Solving sound difficulties is a step-by-step process, he added. Wind noise is solved most readily by providing good sealing. With windows open nobody knows just what to do about the noise, he said. In considerable detail, but briefly, he discussed road noise and its measurement, body mounting, engine noise, fan noise and related problems.

Instrumentation for the measurement of vibration in an automobile was the subject treated by **Aruthur S. Bassette**, of General Motors Proving Ground. He showed a movie of automobiles undergoing road and laboratory shake test and of instrumentation for these methods. His talk dealt with vibrations as low as one cycle per second as contrasted with Ball's discussion of vibrations above 20 cycles. Crystal pick-ups, recorders and oscillators were shown in operation. In presenting his data Bassette classified vibration in the automobile body into frequency ranges from zero to five cycles, including the natural frequency of the sprung mass and the seat cushion underload, which generally constitute the so-called ride of a vehicle; then a second range from five to twenty cycles, and a third from 20 to 100 cycles, which cover the frequencies of various other body structure components and, in the higher range, body panels; the fourth group of vibrations are above 50 and up to more than 5,000 cycles per seond.

Philip O. Johnson, of the structures department, Fisher Body Experimental and Development Section, devoted his attention to static structural testing. His paper emphasized the difference between strength and stiffness.

"The most frequent difference between acceptable and unacceptable body designs usually lies in the field of shake and vibration," he said. "It is of vital importance that static tests be designed to test for that characteristic—rigidity—that most influences these conditions."

Harold A. Hicks, supervisor of the body and mechanical laboratory of Ford Motor Co., presented a careful and analytical discussion of the nature of the loads in body and frame structures. He showed a number of slides illustrating stress patterns made apparent by "Stresscoat." He discussed the use of this technique, combined with strain gages, to develop the intensity data required. Through a series of subsequent illustrations he showed schematic force diagrams under equal wheel loading and compared this with forces under unequal wheel loadings. Finally, he presented some fundamental engineering data pertaining to the design of structures and attachments.

The meeting was concluded with a question and answer period lasting an hour and indicating intense interest on the part of the audience.

Robert S. Lee, of Twin Coach Co., speaking before Montreal Section, Jan. 5

Tell How Fastest Boat Was Designed and Built

• Northwest Section
K. A. Short, Field Editor

Feb. 2—An insatiable desire for speed, plus a scientific approach to the problems of hull design and construction, and the selection, design and placement of propulsion machinery are the primary factors leading to the astounding success of Slo-Mo-Shun IV, present holder of the world's straightaway record of 160.3235 mph, as well as the Harmsworth and Gold Cup trophies, said **Stanley S. Sayres,** owner-driver of the craft.

Sayres introduced the three men who designed and built the hull and step-up gear for the craft, at a joint meeting of the Pacific North-West Section of the Society of Naval Architects and Marine Engineers, and the Northwest Section of The Society of Automotive Engineers in Seattle.

Ted Jones of Boeing Airplane Co., designer, presented a paper on hull design of Slo-Mo-Shun, in which he traced through 24 years the development of the multiple point hull, and described final achievement of the balance and refinement of design which permitted Slo-Mo-Shun to establish such an impressive array of performance records.

Jones pointed out that at speed, Slo-Mo-Shun rides on only 4 sq in. of the surface of each sponson (a projection built out from the side, and below the chine several inches), and the stern is out of the water 8 in., causing only half of the propeller to be in the water. Also described were the spoiler, a device which prevents air pressure build-up, which would turn the boat over backwards at speeds over 140 mph, and the Hi Johnson 2 blade 14 × 25 propeller which is available in positive, negative, or neutral lift, and aids in achieving the fore and aft trim of the craft.

Anchor Jensen, of the Jensen Motorboat Co., presented a paper on construction and outfitting of Slo-Mo-Shun, giving a brief resume of the dimensions, which were as follows: length, 28 ft; width at sponsons, 11 ft, 4 in.; oak frames, mahogany plywood bottom, sides, and deck. Weight complete, but without gas and oil, 4,387 lb, which, with the 1,800-hp Allison engine, gives a ratio of 2.4 lb per hp.

The Allison engine was selected, said Jensen, because it was the only American built motor with the horsepower, light weight, and adaptability necessary. The hull was built around this powerplant, and, as many of the accessories as possible were used just as they were designed for it in aircraft use. The standard coolant pump was used with adjustable pickups on the sponsons, and globe valves on the overboard to maintain a block to prevent steam pockets.

Every item of construction was carefully weighed for its usefulness, and then planned for strength and lightness. Dural sheathing, bonded with rubber and screw-fastened, was provided to assure a smooth, hard, non peeling surface to travel on.

While the hull, despite its light construction, has never leaked, Styrafoam was installed for flotation in case of a major mishap.

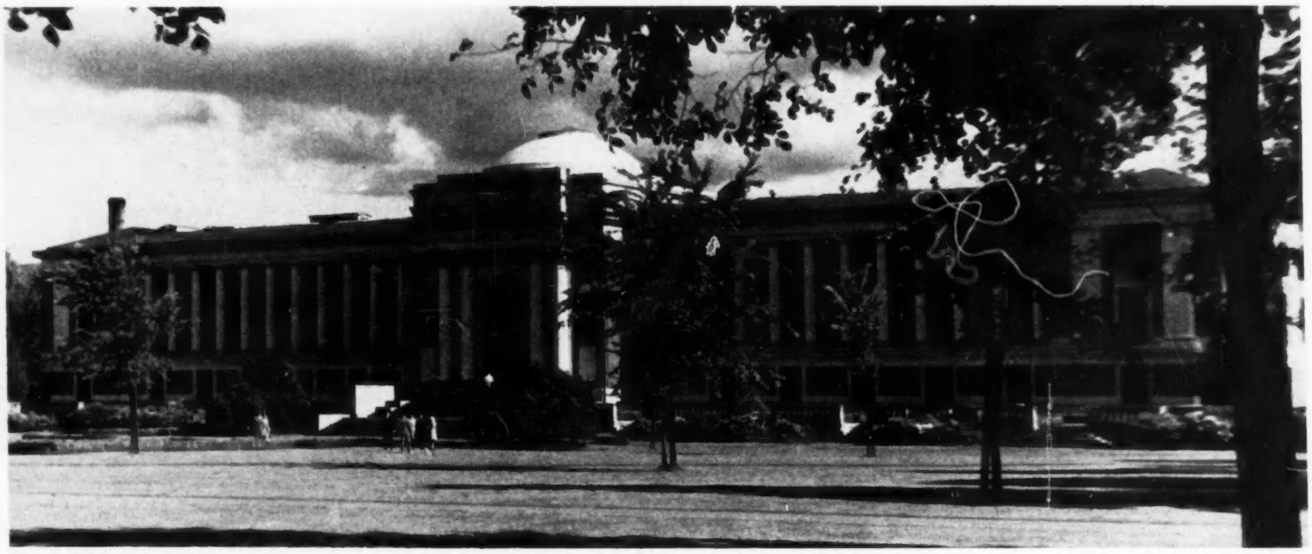
D. B. Spencer, Staff Engineer, Western Gear Works, presented a paper on the design of the step up gear used in Slo-Mo-Shun.

Spencer pointed out that study of race boats in operation disclosed two conditions which had a definite influence on the design of the step up gear and drive system. First, the propeller was not completely submerged, usually only a portion of one blade in contact with solid water, resulting in a propeller load which was extremely irregular and variable, causing a shock loading on the gears, which occurred on the same teeth each revolution.

The second factor was the known tendency toward porpoising motion in rough water, which at times would be violent enough to lift the propeller completely out of the water for periods of 1 to 2 sec, or from 150 to 300 revolutions, then drop the wheel back into solid water, imposing a severe shock load on the whole driving system. During the time the wheel was out of water, the engine, with very low inertia, and no governor, would overspeed dangerously. To protect the engine and drive system from the effects of overspeeding, sufficient inertia was built into the step up gear

Continued on Page 88

Shown at Northwest Section's Feb. 2 meeting are (left to right): (1) Section Vice-Chairman Howard Lovejoy; George Gumm, president Greater Seattle Chamber of Commerce; and Chairman Roy Severin. (2) Speaker D. B. Spencer; Paul Forsythe, sales manager, Western Gear Works; and Speaker Stanley S. Sayres. (3) Meetings Chairman Bob Holmstrom; and Speakers Ted Jones and Anchor Jensen



The center of student activity on the Oregon State campus is this Memorial Union Building

SAE AT OREGON STATE COLLEGE

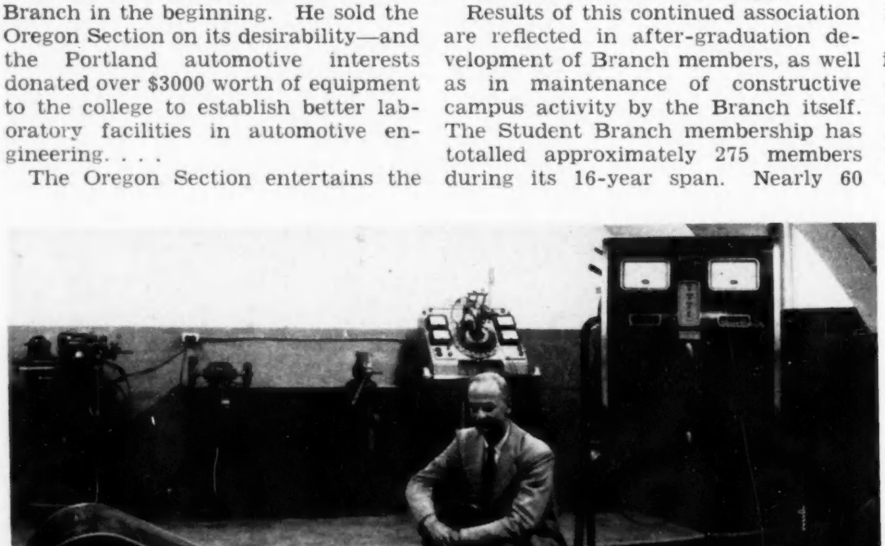
Oregon State College's 16-year old SAE Student Branch has always been closely integrated with the SAE Oregon Section.

Harley Drake, SAE Vice-President for Transportation and Maintenance Activity in 1936, and Oregon Section Chairman in 1932, sparked the Student Branch in the beginning. He sold the Oregon Section on its desirability—and the Portland automotive interests donated over $3000 worth of equipment to the college to establish better laboratory facilities in automotive engineering. . . .

The Oregon Section entertains the Student Branch three times each year in Corvallis on the occasions of the student field trips. One joint meeting with the students is held at the College in the spring. . . . Throughout the years association between the Oregon Section and the Branch has been close and mutually helpful.

Results of this continued association are reflected in after-graduation development of Branch members, as well as in maintenance of constructive campus activity by the Branch itself. The Student Branch membership has totalled approximately 275 members during its 16-year span. Nearly 60 former students of Oregon State College are members of SAE today. Branch membership has been encouraged only among students definitely interested in the automotive field. The average size of the group is about 30 per year. Graduates are to be found in the automotive and petroleum industries throughout the country.

The present generation of students in the Branch cherishes the tradition of cooperation with the Section which started with the Branch's founding. 1950 Student Branch Chairman, Laird McKee, recites with enthusiasm stories of the time when SAE President, D. G.



W. H. Paul, professor of automotive engineering, has been faculty adviser of the Oregon State College SAE Student Branch since its inception in June, 1935. The laboratory in which he teaches contains much equipment which is the fruit of close cooperation between the Oregon Section and the Student Branch

(Barney) Roos talked to the Oregon Section during his presidency in 1934 about front-wheel suspensions—and presented the college with its first new engine for experimental work, a Studebaker President 8. That engine still is serving as a tear-down unit.

Important in the college-industry cooperation and in the Branch's steady progress is Faculty Adviser W. H. Paul, professor of automotive engineering. Himself a member of SAE since 1934, Paul is the only Faculty Adviser the Branch has ever had—and both alumni and students credit him with being a major factor in the Branch's success.

The School of Engineering and Industrial Arts at Oregon State—from which the SAE Student Branch draws its members—was founded in 1908, although the university was chartered as Corvallis College in 1858. It was designated originally as a state agricultural college and graduated its first class in 1870.

Between 1500 and 2000 students now study annually in the School of Engineering and Industrial Arts. The total enrollment for the College runs around 6500 to 7000.

Located at Corvallis, Oregon, the College is 90 miles from Portland where the SAE Oregon Section has its headquarters and meetings.

SAE Members Who Attended Oregon State College Include:

James R. Aaron (**1946-48**), Harold W. Ager, Jr. (**1935-39**), George H. Amberg (**1943, 46**), George Benz (**1938-39**), Ralph E. Black (**1947-49**), Miles Livingston Brubacher (**1943-44, 1946-49**), Bruce W. Carkin (**1946-49**), Howard W. Christenson (**1933-38**), Roscoe W. Clarke (**1938-41, 1946-48**), Jack P. Converse, Jr. (**1941-42**).

James F. Cook (**1933-39**), Nevin Harvey Cope (**1937-41, 1947-49**), Remey M. Cox, Jr., (**1945-49**), Walter J. Crane (**1933-35**), John R. Deffenbaugh (**1941**), James Eugene Doeneka (**1942-43, 1946-49**), M. Lowell Edwards (**1920-24**), Harry W. Fall (**1937-41**), Tore N. Franzen (**1945-47**), R. W. Goodale (**1924-29**), W. V. Hanley (**1927-29, 1931-33**).

Glenn E. Herz (**1938-42**), Ralph J. Hooker (**1924-28**), Robert H. Hornidge, Jr., (**1942-48**), John R. Hulbert, Jr., (**1940-47**), Alf Hundere (**1934-38**), Richard H. Hunger (**1939-43**), E. E. Kearns (**1922-26**), Robert V. Kerley (**1927-31**), Earl M. Kruger (**1938-42**), Lloyd M. Landwehr (**1934-38**).

H. W. Looff (**1912-16**), Ralph N. Lunde (**1922-26**), J. L. Mahon (**1916-21**), Ralph M. McCugh (**1939-42**), E. J. McLaughlin (**1931-35**), Allan Dunbar McLean (**1933-39**), Corwin D. McLean (**1938-43, 1946-47**), Leonard E. Miles (**1919-24**), John G. Mingle, Jr., (**1948-49**), Francis C. Mueller (**1921-24**).

John R. Nelson (**1946-49**), William E. Nunnenkamp (**1937-41**), R. V. O'Donnell (**1926-30**), T. E. Othman (**1934-38**), W. H. Paul (**1922-24, 1934**), Clair L. Pepperd (**1924-27**), Ross A. Peterson (**1924-28**), Perry W. Pratt (**1932-36**), Ralph K. Reynolds (**1937-40, 1948-50**), Jonathan R. Rose (**1947-49**).

John M. Scarlett (**1938-39**), Edward B. Shields, Jr., (**1939-43, 1946-47**), William R. Shimmin (**1942-43, 1946-49**), J. M. Shannon (**1927-29**), Britt M. Smith (**1934-38**), Hugh M. Small (**1938-44**), Richard E. Smith (**1938-41**), H. G. Tarter (**1924-29**), Herbert L. Tollisen (**1939-43**), Dick F. Wagner (**1932-36**).

Edward E. Werlein (**1915-17**), Donald C. Wimberly (**1935-39**), John C. Worthington (**1940-47**).

Continued from Page 85

to keep overspeeding within safe limits.

The necessity of keeping the engine low in the hull for stability imposed limitations which required locating the gear box on the engine bell housing, with a maximum gear center distance of 7.5 in.

To transfer propeller thrust to the engine sills in the simplest manner, the thrust bearing was built into the gear box.

Once the factors of ratio, speed, horsepower, and loading were determined, the design of gears, shafts, and housings was straight-forward, though involved. Spencer declared that the design of highly stressed gear sets is based on an analysis system in which the factors which contribute to gear failure are brought into close balance so that no one type of failure predominates. The anticipated gear life, as calculated, is in excess of 100,000,000 stress cycles or 160 hr at 3,000 rpm engine speed. Inspection of the gear teeth after 20,000,000 stress cycles showed no evidence of fatigue checks, or pitting, or scoring.

In order to cool and lubricate the gears, and yet not have surplus oil on the surface to cause hydraulic pressure stresses, oil spray jets are directed at the teeth just as they leave the mesh print. Centrifugal force throws the excess oil off the teeth, and in so doing creates a finely divided oil mist for cooling the bearings. The oil gathers on the wall of the housing, and runs down into the sump, where it is pumped back to the engine oil system for cooling and filtering.

Spencer pointed out that gear boxes for extremely high speed boats in the past had been notorious for breaking up during a race, or even before the race starts, and expressed hope that a starting point for gear boxes for faster and better boats had been established.

Present Two Sides of "Roads vs Loads" Issue

• Pittsburgh Section

H. K. Siefers, Field Editor

March 5—Mutual problems confronting both the trucking industry and the highway engineers were ably presented by **Emil Gohn** and **H. G. VanRiper** at a symposium on "Roads versus Loads."

Although the participants in this controversial question were not in agreement as to the best present set of regulations, their sincere presentation of the facts and problems of each side

resulted in a most spirited discussion.

VanRiper, chief of highway planning of the Pennsylvania Department of Highways, presented many slides depicting the failure of roads inadequately constructed to carry the modern transportation equipment of today. He pointed out that in Pennsylvania 46% of the primary highways are 20 or more years old, 39% are 10 to 20 years old, with the balance of 15% being highways built within the last ten years. The construction of very few of these roads is adequate for handling our heavy trucks, particularly if they are carrying excess loads, and immediate replacement of all roads with surfaces and bases to carry heavy truck traffic is indeed a formidable task; therefore he advocates adoption of the load limit regulations of the American Association of State Highway Officials in order to preserve these roads and protect the huge investment in the highways of the nation.

VanRiper pointed out that the Pennsylvania Highway Planning Board has proposed a twelve year program in which it recommends a yearly expenditure of $123,000,000 for highway maintenance and construction. This recommendation was based on the assumption that present load limitations will remain in effect.

The highway planning chief further stated that "pumping" is the chief concern of the highway engineers today. This phenomenon takes place when inadequate drainage and poor sub-soil has created a condition that causes the concrete roadway slab to depress under the weight of a vehicle, thereby forcing water and soil from beneath and eventually leaving a cavity so that the slab itself fails from lack of support.

How Pumping Is Corrected

Slides were shown of a remedial procedure for these conditions. A hole is first drilled in the roadway at the trouble spot. Then, with the aid of special pressure equipment, asphalt compound at 375 F is forced beneath the slab so as to replace the lost soil and act as a water barrier. This procedure is claimed to be very successful if carried out in time.

Gohn, who is chairman of the Pennsylvania Motor Truck Association's Equipment and Maintenance Conference, while conceding the weight factor to be a serious matter in the problem of traffic and highway damage, contended that the trucking industry has become such a vital part of the nation's transportation system and general economy that it should not be stifled by severe legislative regulations of loads. He stated that in any controversial subject such as "Roads versus Loads," the overall economics of the picture must be considered. The trucking industry has made it possible to lower transportation costs with the ultimate saving being passed on to the consumer.

Emphasis was directed to the fact that although many roads were failing under the onslaught of weather and heavy truck loads, many other roads were standing up under very severe heavy truck service and unfavorable weather conditions, indicating that faulty design or reconstruction was the main contributing factor in the failure cases depicted.

The Motor Truck Association representative further contended that "The load carrying ability of a well constructed road has not been established," and therefore axle and total weight limits on carriers as proposed by A.A.S.H.O. would retard progress and were "not in the public interest."

Gohn emphasized that in case of a national emergency our highways would be required to withstand, not only unusual commercial loading, but also military vehicular traffic.

Murray Fahnestock, editor, Ford

Field Magazine, ably handled the position of moderator. The automobile editors of several of the Pittsburgh newspapers were present and on the following day published comprehensive reports of the meeting.

Bart Rawson, editor of Commercial Car Journal, came from Philadelphia to attend the symposium and gave an excellent middle-of-the-road talk at the dinner preceding the meeting.

Advocates Better Truck Load Limits

• Philadelphia Section

M. A. Hutelmyer, Field Editor

Feb. 14—Automotive engineers are well ahead of highways engineers in design; the main reason the highway engineer has not caught up is political rather than technical.

This was the concensus of Technical Chairman Frederick Hufnagel, Sun Oil Co., and Speaker **Allan B. Gorman** of Esso Standard Oil Co., who discussed axle loadings that highways should handle.

Gorman's talk was based on the discussion he delivered at this year's Annual Meeting in answer to H. S. Fairbank's paper upholding the 18,000-lb axle loading. (SAE Quarterly Transactions, January, 1951, p. 123.)

He pointed out that in the east, Pennsylvania's restrictive weight law sets up a bottleneck for truck traffic for the entire eastern seaboard. Trucks and trailer trains that carry more than 45,000 gvw (the maximum allowed in Pennsylvania) can travel north and south only by passing Pennsylvania, using New Jersey as a corridor.

Gorman analyzed the formula of the Bates test, showing how it has been used to establish the 18,000-lb axle as a maximum load on a 9-in. pavement. But, he said, further analysis of the test shows that a 9-in. pavement should be good for a load of 19,800 lb rather than 18,000 lb. When the formula is applied to thicker pavements it shows a proportionately greater increase in strength for each increase of unit thickness. Thus a 10-in. slab would support a 24,400-lb axle and an 11-in. slab would allow a 25,500-lb axle.

An 18,000-lb limit puts a straight jacket on development, Gorman said, and is completely out of step with the growth of our economy. It has been suggested that future roads be designed for the normal support of 18,000-lb axle loads, and this figure fixed for maximum load. Gorman not only disagrees with this concept but declared, "Fixation—the word has no place in the vocabulary of American economy. Fixation means stagnation, it means decay. . . . This policy stands

in the way of progress and says 'Stop, this is the end!' "

In reply to the argument that trucks do not pay their way, Gorman pointed out that on the Pennsylvania Turnpike 60% of the revenue is derived from trucks.

He showed slides and gave a general description of the New Jersey Turnpike, which is designed to withstand a 36,000-lb axle load and proves that highway engineers can produce roads able to carry safely, securely, and with a minimum of repair the largest trucks produced by the automotive industry.

Greyhound Engineer Reports on New Buses

• Western Michigan Section
L. W. Kibbey, Field Editor

Jan. 16—Key men in the transportation business from this area as well as from Chicago, New York, Richmond, and Springfield, Mass. were present at this meeting to hear **Milo M. Dean,** chief engineer of Greyhound Corp., give a comprehensive report on design and development of modern double-decked and stepped-deck intercity buses.

Dean joined Greyhound in 1943 when the company decided to enter into development of completely new highway buses. Starting "at the bottom of the barrel," he faced the difficult job of building an organization of men experienced in the field. With all the adversities, including lack of proper tools, the first bus (the GX-1, or Highway Traveler) still was designed and finished in a relatively short time.

The double-deck feature probably is the most visible departure from ordinary buses. Credit for assistance in styling was given Raymond Loewy Associates. Public sentiment, first against the blind spot forward in the lower deck, was reversed before long.

The Scenicruiser, or GX-2, is stepped-deck or vista-dome in design. From original sketches to finished bus, it took only 13 months. Dean said it has been exhibited all over the United States and in regular service for four months, and will undoubtedly be Greyhound's standard bus of the future.

Among its special features are ample room, light-filtering windows, air conditioning, radio, and rest rooms. The window glass provides a diminishing shading from top to bottom so that no passenger has to squint even when the sun is brightest. Skylights are of a semi-mirror type that keeps out objectionable sun rays. The air conditioning keeps temperatures from varying more than $1\frac{1}{2}$ F. Except in weather below 15 F or above 90 F, there is no recirculation of air, and fresh air is provided. Thermostats in the bus predict temperature changes and transmit messages to the unit where vanes are opened and closed to control admission of outside air. The spent air is drawn through ducts running the full length of the bus at floor level.

Public safety was carefully planned by providing turret visibility for the driver. Special instruments, lever, and switches are closely grouped into one panel—so close to the wheel that they can be manipulated without the driver's taking his hands off the wheel. The hydraulic assist in steering, plus easily-operated Bendix power hydraulic brakes, adds to safety assurance.

The GX-1 has two aircooled motors coupled so as to drive a common transmission. Each engine develops 154 hp at 2600 rpm. Weight of the bare engine is 640 lb, but the two, with ac-

cessories, total about 1500 lb. Two sets of ignition are used as a safeguard against stalling on the highway. At 75,000 miles and $2\frac{1}{2}$ years' operation, this bus has yet to be towed into town.

The GX-2 uses a GM 6-71 diesel provided with a special camshaft to increase speed to 2300 rpm. This propels the vehicle at a top speed of 57 mph with a full load of 43 passengers and luggage. Fuel consumption at the rate of 5.68 mpg compares favorably with the smaller standard Silverliners with 6.83 mpg.

Greyhound does not use torque converters or automatic transmissions as they find that their overall operation does not justify it, and their capable drivers can shift manually smoothly enough not to annoy customers with jerky starts. In addition, they get about a mile more per gallon of fuel, which amounts to considerable money when total miles operated amount to 500,000,000 per year.

Dean said he and his associates had to become experts in the electrical, hydraulic, suspension, air conditioning, and similar fields to construct a vehicle so radically different from those in common use. Considerable research and shirt-sleeve engineering were necessary to perfect air cylinder-rubber torsion spring combinations that maintain the same riding qualities regardless of load. The same is true of the air conditioning systems, where prototypes had to be constructed and tried for correct conditioning throughout the entire bus.

In the lively question and answer period following his talk, Dean ably answered questions about dampening out high frequency vibration in springs, details of braking system, air conditioning, costs, maintenance problems, and state legislation on size and weight of buses.

On Feb. 20, members of Western Michigan Section who were unable to attend the 1951 SAE Annual Meeting had an opportunity to get the highlights of papers presented at that time. Five men, each well versed in his subject, summarized papers in five general subjects: diesel, production, fuels & lubricants, ignition, and engineering materials and stresses.

Describe Supplying Of Essentials to Korea

• Detroit Section

George J. Gaudaen

Feb. 19—Six hundred and thirty members and guests were present at this meeting, held under the joint sponsorship of the Aeronautic and Truck and Bus Activities.

At the technical session, two complementary phases of the country's present rearmament program were presented by a civilian from the Ordnance Department, and by an officer from the Military Air Transport Service. **Carl W. Nash**, of the Detroit Arsenal's Research and Development Division, presented a paper on 8-wheel drive, 10- and 15-ton trucks now undergoing tests. **Major W. Gordon Duncan**, of MATS' Traffic Division described how his organization has been getting essential materials produced by Ordnance and industry to Korea with a minimum loss of time.

At the dinner preceding the technical session, **Russell Barnes**, foreign affairs commentator for The Detroit News, emphasized the importance and the urgency of the United States' present rearmament program in reaching a balance of military power with the

Soviet Union. Until this balance is achieved the world situation will remain dangerous, he said, for Russia may be tempted to attack while we are relatively weak.

An example of the United States' rapidly growing strength was presented by Nash's truck paper. Powered with a 500 hp air-cooled engine and equipped with a very flexible set of axles, the trucks which Mr. Nash described have demonstrated their ability to cope with the extremely rugged terrain which may be found under battle conditions. In recently conducted tests, portions of which were shown at the meeting in colored film, the trucks readily climbed steep slopes covered with heavy mud, drove through streams with the engine submerged, climbed small walls from a stand still, and managed to hit a 50 mph pace on smooth pavement.

The 10- and 15-ton ratings of the trucks are the cross-country net payload, but the larger truck is designed for a gvw of 195,000 lb operating as a semi-trailer. In spite of their massiveness, they can be operated with but a little more effort than that required to operate a passenger car, Nash said. This is accomplished through a semi-automatic gear-shift and a well-balanced suspension which distributes the load equally on all tires. The flexibility of the suspension was demonstrated by a projector slide which showed blocks inserted under opposite tires while the truck body remained level.

Nash pointed out that the steering operation has remained relatively easy, even though the turning is done through four wheels mounted on two flexible axles. This was done, he said, largely by making the steering rods one side of a parallelogram with respect to the axle positioning rods.

One hundred and fifty thousand tons, including 275,000 passengers, were carried to and from Korea to the United States over a six month period. With these figures, Major Duncan emphasized the role which MATS has played in the Korean conflict. These figures become even more impressive, he said, when it is realized that at the time the North Koreans launched their attack, the MATS organization had been seriously depleted, so depleted, that it was necessary to practically discontinue other global services, while rushing all equipment into Pacific services. In addition, Duncan related, 60 commercial cargo planes were contracted for to supplement the MATS' equipment. With this scraping and borrowing they were able to raise the airlift tonnages from 70 tons a month to 150 tons in one day.

In his talk, and in an accompanying MATS' movie, Duncan gave extreme examples of the material which has been transported by air to the airbases in Japan and on into the front lines in Korea. These range all the way from human blood to a 420-ton pontoon span which was air dropped to a trapped Marine unit, enabling them to escape across a river barrier.

The film showed the wide variety of planes which have been used to accomplish the MATS' missions . . . from the old C-46 warhorses, still in operation after 10 years of active service, to the new C-119 "Packets" which can carry combat vehicles or a strong fighting unit of fully equipped paratroopers. In all of the aircraft, pallet-type loads are prepared and used. Duncan said MATS has found that pallets have greatly reduced the time required to load and unload the planes, and has also simplified the tie-down problem.

During the question and answer period, Duncan was joined by Lt.-Col. E. W. Guilbert, of the Combat Cargo Command, MATS' operating unit in

Korea. Guilbert had just returned from Korea after a 6 months' tour of duty, and was able to implement many of Duncan's points from his first-hand experience both at the front and at the supply bases in Japan. He related that air-drop technique has been developed to the point where equipment has been dropped to troops with average damage rate only slightly higher than 5% and in some instances as low as 2%.

Discuss Three Phases of Automotive Road Testing

• Detroit Section Junior Meeting

Feb. 26—Detroit Section's Junior Group heard a panel discussion on "Automotive Road Testing" that included talks on performance, endurance, and special problem testing. Speakers were **Robert W. Gaines**, supervisor of the Technical Data Section of Ford Motor Co.'s Engineering Test Department; **H. Paul Bruns**, senior project engineer in the road testing department of Chrysler Corp.; and **Robert W. Burton**, senior project engineer for GMC's Cadillac Motor Car Division.

Talking on "Basic Performance Testing," Gaines said that fuel economy and acceleration probably are most important, because they are what the customer sees in terms of "miles per gallon" and "pickup." The third is interesting because of its influence in determining the other two.

Four different types of economy tests are run, each representing a different set of operating conditions encountered by car owners. Acceleration tests afford a series of automatic readings from which average accelerations for each of a series of consecutive speed intervals can be calculated. Road load power tests determine the power required for the car to overcome wind resistance, rolling friction, and tire losses at any given speed.

Bruns reported that endurance road tests serve as a means of screening, eliminating items which do not stand up under test. Types of test include rough road testing, dust testing, hot weather testing, cold test endurance, splash testing, mountain endurance, tire testing, and competitive car endurance evaluation.

Burton pointed out that performance and endurance road testing are only the beginning. Often the results of these tests indicate what steps need to be taken next. But some problems require standardized procedures almost exclusively (for example, carburetor calibration and development, which requires hundreds of road load economy runs with various meterings and adjustments); other problems require devising a special test program. Special problem road testing, therefore, consists of anything from highly involved instrument testing to simply driving the automobile and observing the results of various changes.

Panel Reports On DTA Program

• Washington Section

Louis Reznek, Field Editor

Feb. 20—This Section got an inside picture of the status of "Automotive Preparedness" when three experts on the preparedness program and government controls reported on the present picture and predicted some future trends.

Panel members were **John H. King**, Washington representative of the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Automobile Manufacturers Association; **Frank G. Stewart**, consultant to the government on many automotive supply problems; and **Douglas Bonn**, Washington representative of U. S. Rubber Co.

The Defense Transportation Administration, they reported, is drafting a program of what is considered necessary to maintain motor vehicle transportation. These data will be submitted to the National Production Administration to insure the availability of adequate highway transport. The tentative DTA program would require about the same number of trucks as were manufactured in 1950—about 96,000 trailers and about 8000 buses.

Present cuts by the NPA in the use of nickel, aluminum, and copper will probably be increased with restrictions on the use of copper probably being the controlling factor. Government agencies recognize and will provide for the necessity for adequate replacement parts. Since railroads could supplant motor vehicles for only about 10% of motor carrier freight transportation, and since about 75% of motor vehicle transportation is considered essential, no steps which would interfere with these essential movements are expected; nor is a "shift" to the railroads.

Because of the present high average age of passenger cars and the essentiality of such transportation, no shutdown of production such as that encountered in World War II is expected, although production will be and has been curtailed.

There are spot shortages in tires, but improvement in necessary-usage areas is expected. Government stockpiling, and the fact that all rubber, natural and synthetic, is acquired by the government and then allocated, has resulted in shortages. But synthetic rubber plants are being put into production and should be able to satisfy needs with the conservation by restrictive usage currently in effect.

Short of an all-out war, no gasoline rationing is expected or, apparently, necessary. The supply is adequate, and additional, recently-discovered oil reserves promise adequate future supplies.

The general picture presented at this meeting was one that showed government realization of the need for motor vehicle transportation, and that steps will be and are under way to assure continuance of such transportation. But restrictive measures are being taken, and are necessary to insure provision for military and essential civilian activities.

SAE Student News

Ohio State University

C. D. Miller of Battelle Memorial Institute spoke at the January meeting on "Combustion as Shown by a High-Speed Camera." He showed movies taken at a speed of 40,000 frames per sec illustrating various phases of the combustion process. Of particular interest were the portions of the film dealing with detonation and its relationship to auto-ignition.

The high speed camera and the method used for filming combustion were developed by Miller in cooperation with the NACA. Photographs were taken through a double plate glass set in the top of the test cylinder. Illumination was supplied from an external source and, reflected into the chamber, was found to be superior to the flame as a light source.

—George T. Morton

25 Years Ago

Facts and Opinions from SAE Journal of April 1926

"The SAE Specifications for Crankcase Lubricating Oils, adopted in March, 1923, have not been recognized generally by the companies marketing oil, but there is, however, a real need for oil specifications acceptable to both automobile builders and oil refiners."—Standardization Activities Notes.

■

"Music is dispensed today purely on the basis of quantity production," C. F. Kettering said at a Cleveland Section meeting. "One saxophone is the equivalent of six violins in volume of noise produced and a 12-piece jazz band equals a 65-piece symphony orchestra. . . . To the ear not too highly trained, the music from one is as good as that from the other."

■

The substituting of yellow for red for the color of automobile tail lights was favored by a large preponderating majority of those voting at the National Conference on Street and Highway Safety in Washington last month. Automotive industry representatives were opposed. (SAE was represented by Past-President H. L. Horning.)

■

"It is my belief that the gasoline-electric combination is the ideal power-unit for motorbuses, especially for city work where frequent starts impose such terrific strains on all the units in the power-generating and transmission system. . . . From the standpoint of efficiency, I believe it will compare favorably with the gasoline mechanically-driven motorbus, even though the odds, theoretically, would be in favor of the mechanically driven vehicle."—A. W. Scarratt, Minneapolis Steel & Machinery Co.

"What is your reaction to the possible use of pneumatic instead of solid tires on future motor coaches?", A. W. S. Herrington asked speaker R. H. Horton, president, Philadelphia Rural Transit Co. Horton replied:

"The question, as I see it, is wholly one of expense. Is the public willing to pay for them? I would not at present say that we would or would not want to adopt pneumatic tires. Without any doubt they ride more easily. There is also no question in my mind that they add to the expense materially . . . but I am firmly of the opinion that the future will see pneumatic tires in general use."

■

Recent work of the aeronautic division of the SAE Standards Committee has been limited largely to cooperation with the Joint Army-Navy Aeronautic Standardization Conference. It is expected that the Army-Navy Standards issued to date will be acted upon by the Aeronautics Division by letter ballot and submitted for publication in SAE Handbook at the Summer Meeting.

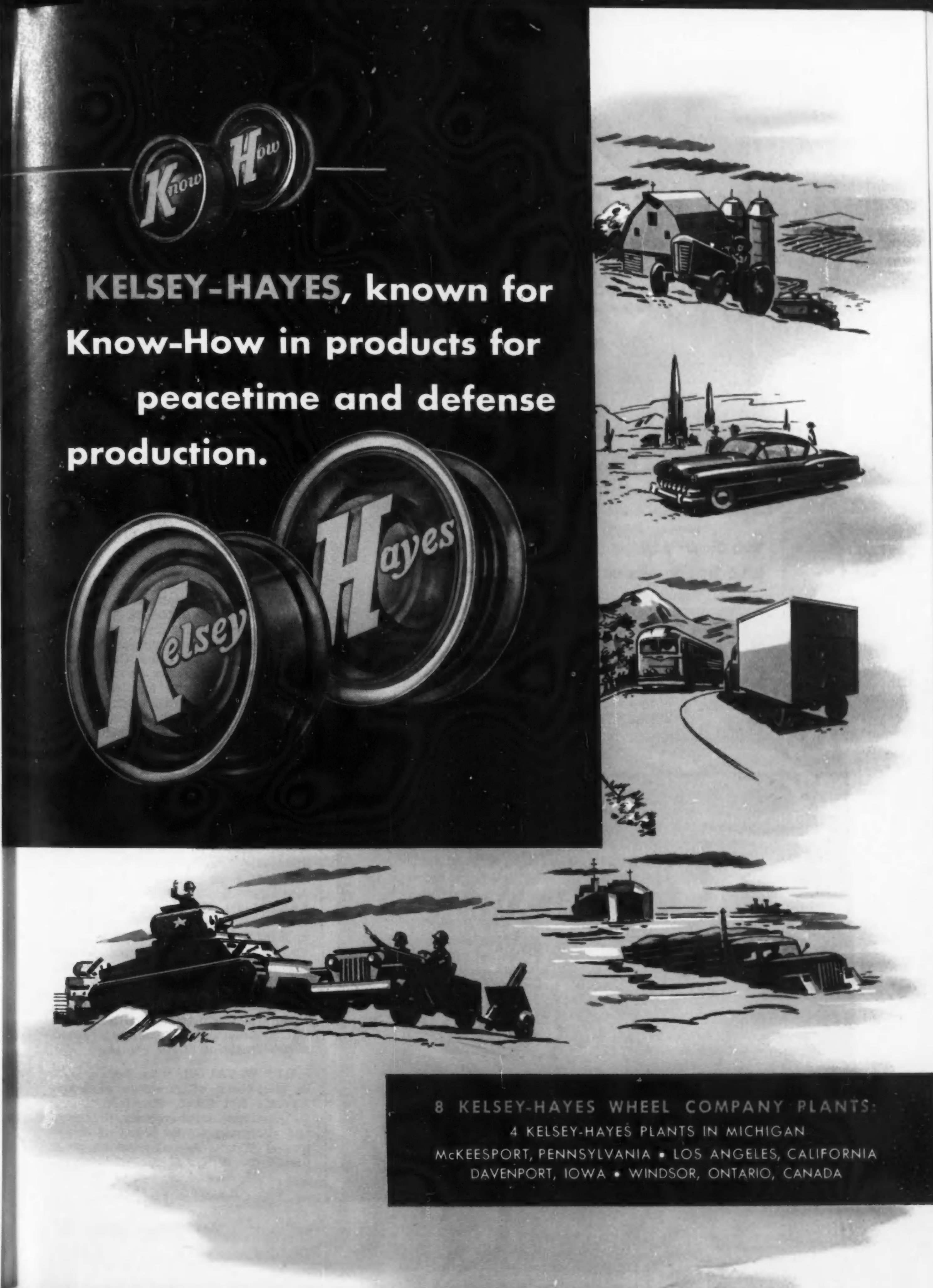
■

Following W. B. Stout's presentation of data on the operation of the Ford airlines during the first six months of service, Stout was asked:

"How long does it take the pilot to open the window at the front of the fuselage when in flight?" Stout answered: "Not more than a second. He pulls a lever and it flies open itself. Asked also was:

"What is the maximum gross weight of one of these ships that flies about 4 mpg of gasoline—and what is the maximum possible load?"

"The weight of the ship, with water, is 3750 lb," Stout replied. "We have been carrying as much as 2750 lb of load commercially."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Personals

Continued

HARRY A. OEST is now a Lieutenant-Commander with the U. S. Coast Guard in Staten Island, N. Y. Prior to this, he was an engineering officer on the Coast Guard Cutter, "Taney." His new position entails the annual inspection of all Coast Guard vessels, floating equipment, lifeboat stations, lighthouses, buoy depots, repair bases, and vehicles within the 1st, 3rd, and 5th Coast Guard Districts, which includes the area from the Canadian border of Maine to the North Carolina-South Carolina border on the east coast of the U. S.

WALTER C. SHAW, formerly a staff engineer with United Air Lines, Inc., San Francisco, is presently assistant project engineer with the Hamilton Standard Division of United Aircraft Corp., East Hartford, Conn. He supervises the development and testing of aircraft accessories in the air conditioning line.

Fourteen SAE members, including Course Director, **AMOS H. NEYHART**, participated as lecturers in the 6th Motor Vehicle Maintenance Course at The Pennsylvania State College Feb. 26 to March 2. The Course is held annually under the auspices of the College's Institute of Public Safety of which Neyhart is the administrative head. The SAE men participating this year were: **WILBUR S. MOUNT**, Socony-Vacuum Oil Co.; **GEORGE A. ROUND**, Socony-Vacuum Oil Co.; **WALTER E. THILL**, Federal-Mogul Corp.; **NORMAN HOERTZ**, Thompson Products, Inc.; **M. R. FRANQUEMONT**, Union Carbide and Carbon Corp.; **RALPH K. SUPER**, Timken Detroit Axle Co.; **J. R. BARTHOLOMEW**, Eaton Mfg. Co.; **ROBERT GRAY**, The Leece-Neville Co.; **MILTON J. KITTLER**, Holley Carburetor Co.; **W. S. BRINK**, Firestone Steel Products Co.; **J. WILLARD LORD**, Atlantic Refining Co.; **HOY STEVENS**, American Trucking Associations, Inc.; **H. B. FORD**, GMC Truck and Coach Division.

WILLIAM J. CARRY, formerly assistant to the president, B. G. Corp., Valley Stream, N. Y., has been elected a vice-president of the company.

GUY W. VAUGHAN has been elected to the board of directors of Boots Aircraft Nut Corp., Stamford, Conn. Vaughan was, until recently, president and chairman of the board of directors of Wright Aeronautical Corp. of the Curtiss-Wright Corp. He is chair-

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Personals

Continued

man of the board of directors of the Marquette Metal Products Co., the L. G. S. Spring Clutch Corp., and the Victor Animatograph Corp. Vaughan holds directorships in Aircraft Industries of America, Manufacturers Trust Co., and Western Electric Co.

W. A. WITHAM is now technical advisor to the executive department at Miehle Printing Press & Mfg. Co., Chicago. Prior to this, he was manager of engineering with Western Gear Works, Lynwood, Calif.

RICHARD ERNEST STEWARD, who had been assistant superintendent of maintenance with Massachusetts Institute of Technology Flight Facilities, Bedford Airport, Mass., is presently field service representative with Fairchild Aircraft Division, Fairchild Engine & Airplane Corp., Hagerstown, Md.

JOHN M. SCHNETZLER is presently a field engineer with Wright Aeronautical Corp., Wood-Ridge, N. J. He was formerly assistant powerplant engineer with Pan American World Airways, Inc., Latin American Division, Miami, Fla.

HOWARD IRA MINSON, previously co-owner of Automotive & Industrial Machine Shop, Richmond, Va., is presently machine shop foreman with Richmond-Engineering Co., Inc., of that same city.

RALPH E. HENSLEY is now vice-president of Cole-Kelly Equipment Corp., Richmond, Va. Prior to this, he was owner of the Hensley Truck Body & Equipment Co. of that same city. He is now in charge of body shop, design and production.

R. M. FRANCIS has been appointed chief project engineer at Pacific Airmotive Corp., Burbank, Calif. Francis went to PAC from Douglas Aircraft Co., where he served as design engineer prior to joining Pacific in 1948.

THOMAS M. LOGAN is now with the U. S. Army in Fort Leonard Wood, Mo., holding the rank of lieutenant-colonel. Prior to this, he was manager of service development with the Caterpillar Tractor Co., Peoria, Ill. His position entails the training of engineer service type units, and the operation of specialists schools for diesel engines and construction equipment mechanics.

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Personals

Continued

RICHARD L. ALLBRITAIN, formerly manager of the Mobile Unit Division of Precision Scientific Co., Chicago, is now employed by Gramm Trailer Corp., Lima, Ohio, in the Engineering & Technical Products Division.

JOHN MacDOUGAL is now a member of the technical staff at Bell Laboratories, Inc., Whippany, N. J. He was previously employed as a motor equipment engineer by the Michigan Bell Telephone Co., Detroit.

FRANK B. THOMPSON, manager of the Montreal office of Harry E. Foster Advertising Ltd., Montreal, Que., was appointed Secretary of Science '25, McGill University, at their recent twenty-fifth meeting.

G. P. H. JOHNSTONE, Ferodo Division, Atlas Asbestos Co., Ltd., has been appointed equipment sales manager of the Ferodo Division.

DR. P. H. SCHWEITZER, professor of engineering research at The Pennsylvania State College, will present a paper to the International Internal Combustion Engine Congress in Paris in May. Dr. Schweitzer's paper, "Research on Exhaust Pipes," is based on an investigation he and staff members of the engineering experiment station have been doing for the past four years under contract with the Office of Naval Research. His research for this paper was done with the assistance of **DR. T. C. TSU**, associate professor of engineering research at the college. This paper and 79 others prepared by representatives from other countries will be presented at the congress. Dr. Schweitzer is the only representative from this country on the program.

WRIGHT A. PARKINS, engineering manager of Pratt & Whitney Aircraft, Division of United Aircraft Corp., has been made a member of the industry and educational advisory board of the U. S. Air Force's Arnold Engineering Development Center at Tullahom, Tenn.

J. H. MILES, previously sales engineer with Richards Wilcox Mfg. Co., Aurora, Ill., is presently powerplant engineer with Beech Aircraft Corp., Wichita, Kans. His new position entails the installation of powerplants in airframe and design of installation details.

DAVID H. MIKKELSON is now connected with the Schuman Carriage Co., Honolulu, Hawaii, as service manager. The company is the island distributor for Cadillac, Buick, Chrysler, Plymouth, De Soto, Fargo trucks and White trucks.

EDWARD N. COLE, plant manager at the Cleveland Tank Plant Cadillac Motor Car Division, GMC, directed a panel discussion covering, "Implementing Engineering Cooperation for National Defense," at the Second Industry-College Conference by the relations-with-industry committee of the American Society for Engineering Education, held in January at Case Institute of Technology, Cleveland.

LYMAN A. WINE, formerly assistant to the president of The Electric Auto-Lite Co., Toledo, Ohio, has been elected vice-president of the company. Wine was promoted to the post of assistant

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Personals
Continued

to the president in 1949, after serving since 1942 as sales manager of the Lamp Division of Auto-Lite. Previously he had been sales manager of the C. M. Hall Lamp Co., Detroit, for 23 years.

DAVID W. RICE is now employed in the Instrument Division of Thomas A. Edison, Inc., West Orange, N. J., as district representative. Prior to this, he was a sales engineer with that same company.

SAE members of the newly-formed Metallurgical Advisory Board are: **WALTER E. JOMINY**, supervisor of metallurgical research, Chrysler Corp.; **DR. A. B. KINZEL**, president, Union Carbide & Carbon Research Laboratories, Inc.; **EARLE C. SMITH**, chief metallurgist, Republic Steel Corp.; and **DR. CLYDE WILLIAMS**, director, Battelle Memorial Institute. Organized by the National Academy of Sciences-National Research Council under a contract with the Research and Development Board, the Metallurgical Advisory Board held its first meeting on Feb. 7 at the National Academy in Washington. The Board has been formed to advise the Research and Development Board, Department of Defense, on research aspects of some of the nation's most critical metals problems.

GORDON I. McNEIL, formerly a sales engineer with The Goodyear Tire & Rubber Co., Detroit, is now chief engineer in the Military Rubber Division of Standard Products Co., Detroit.

ELMER H. SPRING, who, prior to this, was a designer with Ross Operating Valve Co., Detroit, is presently a project engineer with Hannifin Corp., Chicago. He is now engaged in the design and development of a new series of air valves for industrial purposes.

DUANE S. HEFTY is now chief engineer with South Whitley Industries, Inc., South Whitley, Ind. He formerly held a similar position with Wire Assemblies Corp., Detroit. Hefty is now in charge of all engineering plant maintenance.

JOHN E. KAWECKI is now employed as a tool engineer in the Methods & Equipment Division of Cadillac Motor Car Division, GMC, Cleveland Tank Plant, Cleveland. Prior to this, he was a project engineer with the Reliance Electric and Engineering Co. of that same city.

MARVIN N. BIRKEN is now a tool designer with the Axelson Mfg. Co., Los Angeles, Calif. Prior to this, he was an X-ray engineer with Industrial X-ray Engineers, Seattle, Wash.

GILBERT WAY, Ethyl Corp., was honored by over 100 of his friends and associates of the Coordinating Research Council, at a reunion held in Detroit on January 9, of participants in vapor lock and octane requirement tests, made on military equipment at western desert training camps during World War II. For the past several years Way has been West Coast technical contact for the Research Laboratories of Ethyl Corp., Detroit.

ARTHUR A. AYMAR, who, prior to this, was development and project engineer with Bendix Aviation Corp., Scintilla Magneto Division, Sidney, N. Y., is now a technical engineer with the Aircraft Gas Turbine Division of General Electric Co., Cincinnati, Ohio.

Continued on Page 108

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Personals

Continued

K. THEODORE KORN is now a senior associate with Korn, Krieger & Associates, Cleveland. He was previously chief industrial engineer with Electroline Mfg. Co. in that same city.

CASIMIR S. KOPEC, formerly gear designer with Ford Motor Co., Engineering Laboratories, Dearborn, Mich., is now staff engineer with the American Gear Manufacturers Association, Pittsburgh, Pa. Kopec is a graduate of the University of Pittsburgh, holding a B. S. degree in mechanical engineering. Practically all of his business career has been spent with General Motors Corp. and the Ford Motor Co., Research Laboratories, specializing in gear design.

DOUGLAS T. LEWIS, previously a junior engineer with GMC, Product Study #3, General Motors Technical Center, Detroit, is now a designer with that same company. He is engaged in hydraulic torque converter design and development.

SHELDON G. LITTLE is now a staff engineer in charge of testing and development with the Cadillac Motor Car Division, Cleveland Tank Plant. Prior to this, he held a similar position with Cadillac in Detroit.

HARRY J. GRAHAM has recently been appointed chief design engineer of Lear, Inc., Grand Rapids, Mich. Graham has been with Lear for approximately $1\frac{1}{4}$ years. His experience, prior to that, was as project engineer with Packard Motor Car Co., Menasco Mfg. Co., and Wright Aeronautical Corp. on aircraft jet engines.

JAMES RICHARD PETTERS, previously a junior engineer with The Linde Air Products Co., Tonawanda, N. Y., is now an ordnance engineer at the U. S. Naval Proving Ground, Dahlgreen, Va., where he is running tests on aircraft ordnance equipment such as bombs, rockets, and pyrotechnics.

B. D. NEWMAN is now a project engineer in the fuel cell department of Dominion Rubber Co., Ltd., Montreal, Quebec. He was formerly an industrial engineer with that same company.

R. J. SCHONITZER, formerly a junior engineer with the Schonitzer Engineering Co., Cleveland, Ohio, is now president and general manager of Pressed Steel Products Co., Cleveland, Ohio.

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Personals

Continued

C. H. LATIMER-NEEDHAM, chief engineer of Flight Refueling Ltd., is the author of the recently published book, "Refuelling in Flight". The book traces history and development of the flight refuelling technique, discusses its economics for both military and commercial operation. Shown too, are desired design features for both the flight-refuelled airplane and the tanker. The book is an outgrowth of a paper given by the author at the 1949 SAE Annual Meeting. Publisher of this 189-page book is Sir Isaac Pitman & Sons, Ltd.

R. L. McWILLIAMS has been promoted to head of the Technical Data Section, Engineering Staff, GMC, Detroit. Prior to this, he was assistant head of the Section.

B. E. MILLS is now manager of the automotive department of Standard-Vacuum Oil Co., New York, N. Y. Prior to this, he was director and general manager of Atlantic Union Oil Co., Wellington, New Zealand.

WARREN MERRILL is now procurement and process engineer, General Engineering & Design Co., Detroit. He was previously a process layout engineer with Sperry Gyroscope Co., Inc., N. Y.

D. WILLIAM EVANS is now company commander of the 112th Ordnance Medium Maintenance Co., U. S. Army at Camp Edwards, Mass. Prior to this, he was project engineer with Towmotor Corp., Cleveland, Ohio.

LEONARD J. HADDEN, previously a junior engineer in engine testing with Chevrolet Flint Mfg. Division of GMC, Flint, Mich., is now a statistical engineer with Willys-Overland Motors, Inc., Toledo, Ohio.

HARVEY FIRESTONE, JR., is a member of the recently appointed "President's Commission of Internal Security and Individual Rights". This is the civilian agency named by President Truman and headed by Admiral Chester Nimitz to figure out a way of testing people's loyalties while preserving their civil rights. Firestone is chairman of the board of Firestone Tire & Rubber Co.

LEROY A. DIFFORD, previously field engineer with the Textile Equipment Corp., Greenville, S. C., is now a senior draftsman with Warner & Swasey Co., Cleveland, Ohio.

Students Enter Industry

JOHN M. RITCHIE (University of Massachusetts) to Union Carbide & Carbon Corp.

GEORGE F. HOGBERG, JR., (Bradley University '50) to Greenlee Brothers & Co., Rockford, Ill.

JAMES F. McGOWAN (Lawrence Institute of Technology '50) to Midland Steel Co., Detroit.

ROBERT BERNARD BENJAMIN (University of Illinois) to U. S. Civil Service, Wright-Patterson Field, Dayton, Ohio.

CHARLES L. TEETER (University of Wisconsin) to National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland.

JAMES MILTON ZIMMER (Chrysler Institute of Technology) to Chrysler Corp., Highland Park, Mich.

PETER L. PETERSEN (California State Polytechnic College '50) to Lockheed Aircraft Corp., Van Nuys, Calif.

HAROLD W. BUENGER (University of Wisconsin '51) to Bucyrus Erie Co., South Milwaukee, Wis.

CHARLES D. SOPPETT (Michigan State College '50) to Atomic Energy Commission, Chicago.

DONALD T. CHASE (Michigan State College '50) to B. F. Goodrich Co., Akron, Ohio.

ROBERT C. HOAGLIN (Tri-State College '50) to Goodyear Tire & Rubber Co., Akron, Ohio.

LEONARD A. LINDELOF (Parks College) to Federal Aircraft Works, Minneapolis, Minn.

RICHARD I. HIMMELBERGER (Cal-Aero Technical Institute '50) to Century Engineers, Inc., Burbank, Calif.

RICHARD V. RUBLY (University of Colorado) to Aerojet Engineering Corp., Azusa, Calif.

HENRY JOHN LOEWENTHAL (Illinois Institute of Technology '51) to General Electric Co., Bridgeport, Conn.

ALBERT F. WILCOX (Indiana Technical College) to General Electric Co., Fort Wayne, Ind.

GEORGE D. DEVEAUX (Northrop Aeronautical Institute '50) to Northrop Aircraft, Inc., Hawthorne, Calif.

WILLIAM H. HATTON (University of Colorado '50) to Colorado Fuel & Iron Corp., Denver, Colo.

JEROME F. MADDEN (Northrop Aeronautical Institute '50) to North American Aviation, Inc., Los Angeles.

CLARENCE WILLIAM JOHNSON (University of British Columbia '50) to Barber Machinery Co., Ltd., Canada.

CLAY CLARENCE BAILEY (Northrop Aeronautical Institute) to Consolidated-Vultee Aircraft Corp., San Diego, Calif.

JAGADISH CHANDRAN (Parks College '51) to International Civil Aviation Organization, Montreal, Canada.

JAMES D. POTTINGER (Parks College '51) to Chance Vought Aircraft Division of United Aircraft Corp., Dallas, Texas.


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Nelson Auto-Thermic
Diesel
Trans Slot
U-Slot
Heavy Duty
Wing Insert
Two Cycle
Steel Truss
Turbulator head
T-Slot
Trunk Type
STERLING ALUMINUM PRODUCTS INC.
ST. LOUIS, MO.

New Members Qualified

These applicants qualified for admission to the Society between Feb. 10, 1951 and March 10, 1951. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Atlanta Group

T. Erwin Dicks (A).

Baltimore Section

William D. Fulton (J), Daniel Anthony Joseph Misiora (SM).

Buffalo Section

Edward Randolph Dye (M).

Canadian Section

John Stretton Coyne (M), J. S. Smeaton (J).

Central Illinois Section

Benjamin P. Baer (J), Randolph C. Barnes (M), L. A. Blanc (M), P. Frederick Himmel (M), Robert Catlett Howell (J), Alan L. McLees (J), Dwight W. Parken (A), Norman L. Woolgar (J).

Chicago Section

Joseph S. Cardillo (M), John J. Dreznes (M), Donald H. Fidler (J), James C. Green (J), Harvey J. Hincker (M), Clarence S. Schuster (M).

Cleveland Section

Arlie Lyman Brown (J), John W. Carter (J), James T. Davidson (J), John Dinda (J), Albert Raymond Griesbach (J), Edgar T. Horsey, Jr. (A), Ivan R. Kacir (J), James H. Kramer (J), R. A. Paetz (M), Robert B. Resek (M), William Windsor Roy (A), Andrew P. Slivka (M).

Dayton Section

Walter Edward Benulis (J), Clair M. Crispen (J), Marvin R. Davis (J).

Detroit Section

Henry S. Budden (J), Nicholas P. Christy (J), William Corley (J), Michael J. Durella (J), John C. Eckert (J), Richard Cullen Edwards (J), Bill Gorden (M), Robert W. Graham (J), Roy T. Heady (J), William F. B. Henderson (A), Alex Hunter (M), Harold R. Payne (J), Leslie K. Thome (M), Guy E. Watson (J).

Hawaii Section

E. Braunlee Clewett (A), William Henry Maguire (A).

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DETROIT Universal Joints are Available
For Practically Every Field of
Power Transmission

New Members Qualified

Continued

Indiana Section

John N. Eustis (J), William C. Gingrich (J), Arthur I. Lewis (M), John H. Sears (J), John C. Walter (J).

Metropolitan Section

William J. Bigley, Jr. (J), Frank Cousar (M), William Fassuliotis (J), Brice H. Hereford (A), Royal F. Kelly (A), Edgar Arnold Nacke (A), Charles J. Stenson (M).

Milwaukee Section

Darwin Tillman Anderson (J), Rollin John McCrory (J), Arnold J. Merickle (A), Richard Palmer Parshall (M), W. A. Roberts (A).

Montreal Section

S. Krzyczkowski (M).

New England Section

Seth E. Dunklee (M), John D. MacKenzie (A), Henry W. Pratt (A), William B. Yacus (J).

Northern California Section

Bruce Howard Kellogg (M), Robert William O'Hara (J).

Northwest Section

Frank Kreiner (J).

Oregon Section

James Eugene Doeneka (J), Jonathan R. Rose (J).

Philadelphia Section

Josiah French (M), Carl W. Hall (J), Louis J. Palmer (M), Robert Yeakel Rusling (J).

Pittsburgh Section

Ralph N. Stoner (M).

St. Louis Section

Robert O. Dietz, Jr. (M).

San Diego Section

Joseph R. Greene (A), Frank G. Harkins (M), James A. Hendricks (M), Lawrence J. LaFlamme (M).

Southern California Section

Clifford H. Anderson (J), William Edgar Bethel (M), Alvin E. Conant (A), Eugene D. Greene (M), Roy C. Johnson (A), John H. Kinsley (A), Darrell Page (J).

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Bendix Products Division
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Aviation's remarkable progress during the past quarter of a century, together with the growing complexity of aircraft design, have created innumerable new problems in fuel metering and landing gear—many so challenging that only the great creative skill of Bendix Products has been equal to the task.
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Landing Gear Wheels for all types of airplanes
Pneudraulic* Shock Absorbing Struts
Segmented Rotor Brakes
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LEADER IN LANDING GEAR

New Members Qualified

Continued

Southern New England Section

Rodger John Ryberg (J).

Syracuse Section

Dean Clarence Broughton (M), Paul W. Wyckoff (J).

Texas Section

Charles Richard Overly (J), Wix C. Thorpe (J), Floyd Lewis Williams (M).

Western Michigan Section

Charles E. Bluhm (J).

Outside of Section Territory

John R. Cambron (M), Louis J. Elliott (M), Thomas Homer Evans (M), Howard Merle Hauser (J), William Harrison Kite, Jr. (M), Walter M. Kobler (J), John T. Woodruff (J).

Foreign

Miles Livingston Brubacher (J), Saudi Arabia; Johan Lodewijk Gerrit Kohler (FM), Holland; Douglas Joseph Nelson (FM) Ireland; Munjandira S. Somaya (FM), India.

Applications Received

The applications for membership received between Feb. 10, 1951 and March 10, 1951 are listed below.

Atlanta Group

Ernest D. Troutman.

Buffalo Section

Reidar A. Tollefsen.

Canadian Section

George Carson Bradley, Frank Dowell Crowder, John H. Dunlop, Jack Wanless Hasen, John McHugh.

Central Illinois Section

John Vocelka, Harold H. Wagner.

Chicago Section

William Howard Borling, R. N. Coleman, Wallace N. Collett, C. H. Crawford, Harvey B. Gunn, R. C. Gunness, George Edward Hiscott, IV, Blake H. Hooper, Christian L. Jensen, Charles W. McDonald, I. E. McWethy, Vernon N. Paulson, Frank C. Schuster, Chandar B. Singh, William C. Swanson, Evert Lloyd Venstrom, Ross G. Wilcox.

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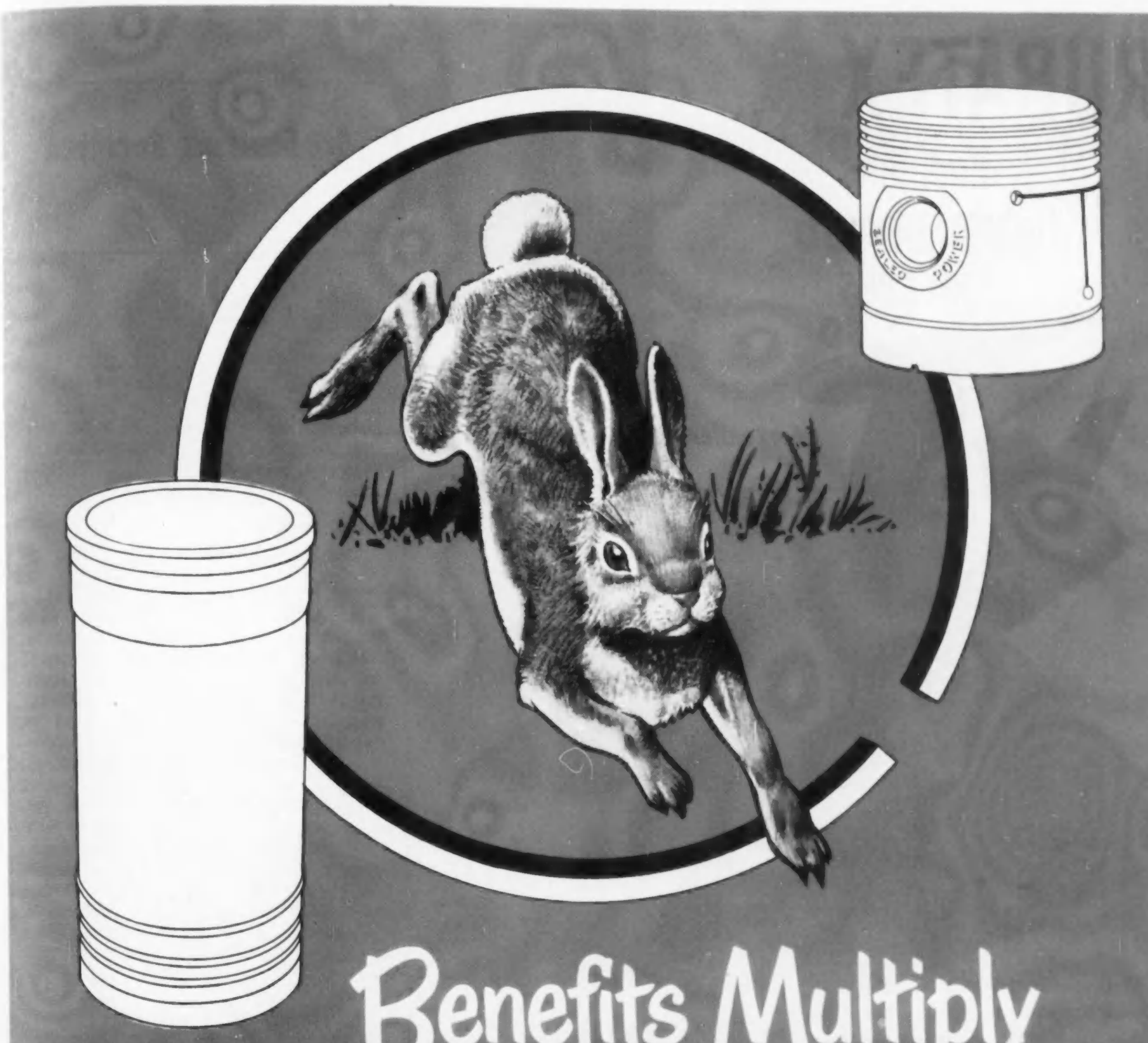
SEALED
POWER
Benefits Multiply
Contrary to the enthusiastic accusation of some customers, Sealed Power does not pull engineering rabbits out of hats. But users of Sealed Power Rings, Sleeves, and Pistons agree on the multiple benefits deriving from Sealed Power leadership.
Today's Sealed Power staff and facilities are the finest in the industry. You are urged to use them to help make your good engines even better.
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MUSKEGON, MICHIGAN
Sealed Power
PISTON RINGS · PISTONS
CYLINDER SLEEVES

Applications Received

Continued

Cincinnati Section

Harry R. Burdick.

Cleveland Section

Norman A. Bast, John T. Crawford, Albert M. Currier, Jr., Donald R. Dreger, Dwain E. Fritz, Paul M. Hetrick, Joseph Kepic, Jr., Harold E. Link, Robert L. Nancarrow, Bernard T. Novy, Zane C. Odenkirk, Norman C. Zollar.

Dayton Section

Thomas L. Deger.

Detroit Section

R. Arthur Gaiser, William Gunn Boales, Jr., Roy C. Bowers, James L. Cleary, P. Ken Cummings, George J. DeLisle, Billy Jay Ellerthorpe, Richard H. Fashbaugh, William R. Gillette, Kenneth Carl Haisenleder, David W. James, Mark A. Lightfoot, Chris William Madson, Gordon I. McBain, Louis Ivo Monti, James T. Moore, John J. Nopper, George Harold Pickering, Arnold O. Pohto, Paul Prior, Robert Bedford Pogue, Jr., Donald Wayne Reynolds, Arthur Rudolph, George Seeger, Jr., Stephen J. Shomberger, G. Neilan Smith, John N. Straky, Robert A. Stranahan, Jr., Louis F. Stuckey, Alec B. Thomson, Robert O. Williams, William L. Woodward, Jr.

Indiana Section

Edward S. Pascoe.

Kansas City Section

Meredith C. Howell.

Metropolitan Section

Paul M. Bishop, Ralph I. Bost, Jack R. Forsyth, William H. Francisco, Jr., Thomas J. Harris, Joseph P. Koplick, James B. Lightburn, Fred M. Morris, Edward H. Raiguel, Charles A. Sereno, Mark H. Smith, John H. Vanderbilt.

Mid-Michigan Section

Ralph S. Parks.

Milwaukee Section

Howard R. Turtle, Jr.

Mohawk-Hudson Section

James C. Huntington.

Montreal Section

L. Jacques Cartier, E. Gray-Donald, Leslie W. Douglas, Philip B. French, Robert F. Grannary, Edward Evan Higgins, William O. Horwood, Leonard James Macdonald, William Earle MacKenzie, Arthur Thomas Roblin, Robert

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Applications Received

Continued

Short, Joseph Arthur William Torch, Edward John Wickenden.

New England Section

John Ellis Jorgensen, Edgar Rose.

Northern California Section

Major Harry Chandler Olson, S. Cameron Hackney, Henrik A. Hilstrom.

Northwest Section

Phil E. Parks, Ralph J. Shields.

Oregon Section

Jack D. Mitchoff, Ray Preston.

Philadelphia Section

Raymond Earl Balbach, Walter Leedom Dutton, Harold C. Grannas, Raymond J. Thomas.

Pittsburgh Section

Richard J. Reich.

St. Louis Section

Eph Howard.

Southern California Section

James P. Atwood, Darell Boyd Harmon, Jr., Dan L. Hicks, K. A. Krekorian, B. C. Monesmith, Ralph Edward Owens, E. Arthur Thompson.

Southern New England Section

T. Joseph Keane.

San Diego Section

Ernest F. Mellinger, Dennis Owen Samuelson, Howard J. Streich.

Spokane-Intermountain Section

Ralph K. Reynolds.

Texas Section

Jarrell W. Bragg.

Washington Section

Edward B. Heyl.

Western Michigan Section

Ian K. MacGregor, Benjamin F. Park.

Outside of Section Territory

Lee V. Brown, Frederick George Forster, Howell H. Heck, William N. Hinds, David H. C. Hoh, Rene G. Lamadrid, Benjamin McLain, Robert W. Parker, Cyril Standen, John Neville Stewart, Edward J. Sullivan, Eugene L. Towle.

Foreign

Marcelo A. Ramos, Philippines; James Waugh, England.

For the Sake of Argument

No Ignorance, No Mysteries . . . .

By Norman G. Shidle

"Were it not for ignorance, there would be no mysteries," we heard President William Todhunter Hall of Ivy College say over the radio the other night. Ivy College exists only in a script-writer's mind and President Hall is known to his intimates as Ronald Colman, but we've been pondering his words nonetheless. It's the kind of quip C. F. Kettering is wont to make when talking about research.

When we realize how many things are mysteries to us, we are astounded at the breadth and depth of our ignorance . . . . particularly about small, everyday matters.

Expressed in the minutiae of human affairs, our ignorance appalls us more than in the important things we don't understand. Inability to comprehend the Einstein theory affects our daily efficiency very little. . . . But questions like "Why would anybody add two and two and get five?" keep cropping up all the time. "What she sees in *him* is a mystery to me" is so often heard as to indicate a more or less universal ignorance about what anybody sees in anybody else.

For many of us the most pertinent mysteries involve the reaction of others as compared to our own in response to given stimuli or situations. Why we really enjoy spinach remains a permanent mystery to scores of our associates. We are similarly ignorant of what intrigues some of them with ballet. What makes this one irritated by a given action, and that one pleased are daily mysteries to most of us.

A long step in reducing these areas of ignorance in man's relations with man is assuming to start with that others will probably react differently than we do. That alone reduces the number of surprises we get—and surprise upsets more of us than it calms. Each of us tends to feel that his own approach is right and normal—which makes difficult observance of an opposite approach without some feeling to start with that it is wrong.

So, we are more likely to reduce the quantity of mysteries faced by understanding other people than by trying to learn the facts about all the sciences of which we are ignorant. We can use the knowledge of what makes people tick almost every day. Only occasionally can we make effective our knowledge of the aardvark and the zythum; of abiosis and zymurgy.